Advanced HF Radio Techniques

Automatic Link Establishment (ALE)

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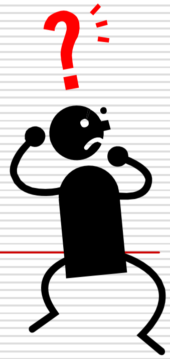
Why HF?



- Realization that satellite and terrestrial communication modes are vulnerable to electronic countermeasures and physical destruction
- HF, although of much lower overall reliability and limited data bandwidth than other communication bands, allow communication over long distances and can be expected to function throughout a global conflict
- Recover more rapidly from the effects of nuclear detonations
- This level of survival and recovery may not be the case for satellite and terrestrial communication modes

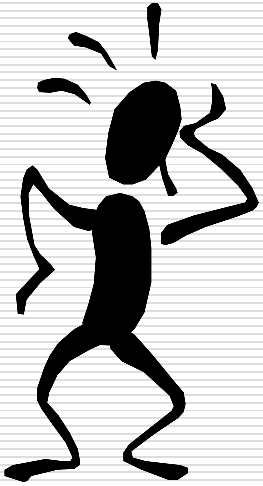
The Problem…

- The High Frequency (HF) band, 3-30 MHz., has always been heavily used with broadcast, mobile, fixed, maritime, aeronautical, and amateur allocations
- Because of the world-wide propagation characteristics of HF, this band has proved to be very reliable
  - In some past emergency situations has been the only communications system available for contact with isolated groups of people
- During times of national emergency HF systems have proven to be and will continue to be critical elements of wireless communications
- However, **reliable transmission in the HF band is complex** with conditions changing:
  - Diurnally
  - Seasonally
  - with solar conditions
  - with other ionospheric conditions

The Result?

Prediction Programs

Frequency Planners

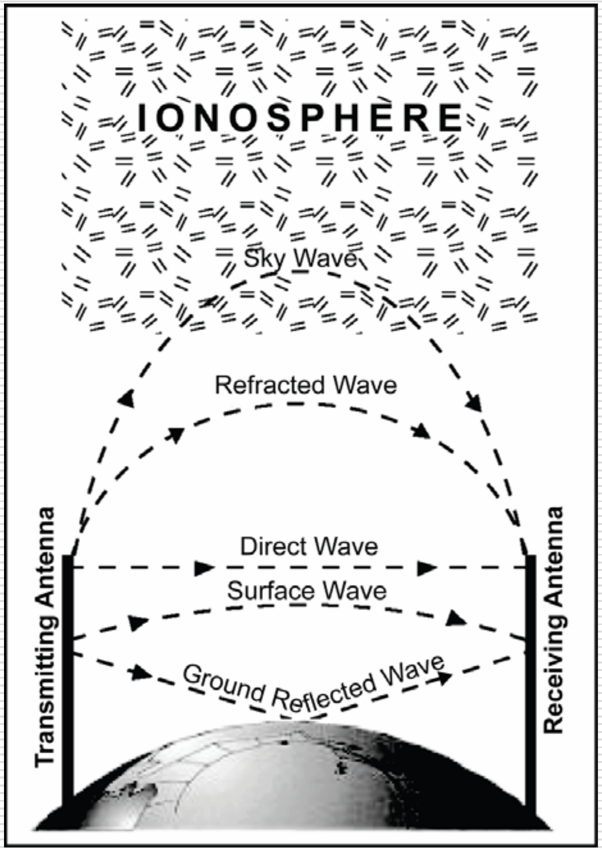


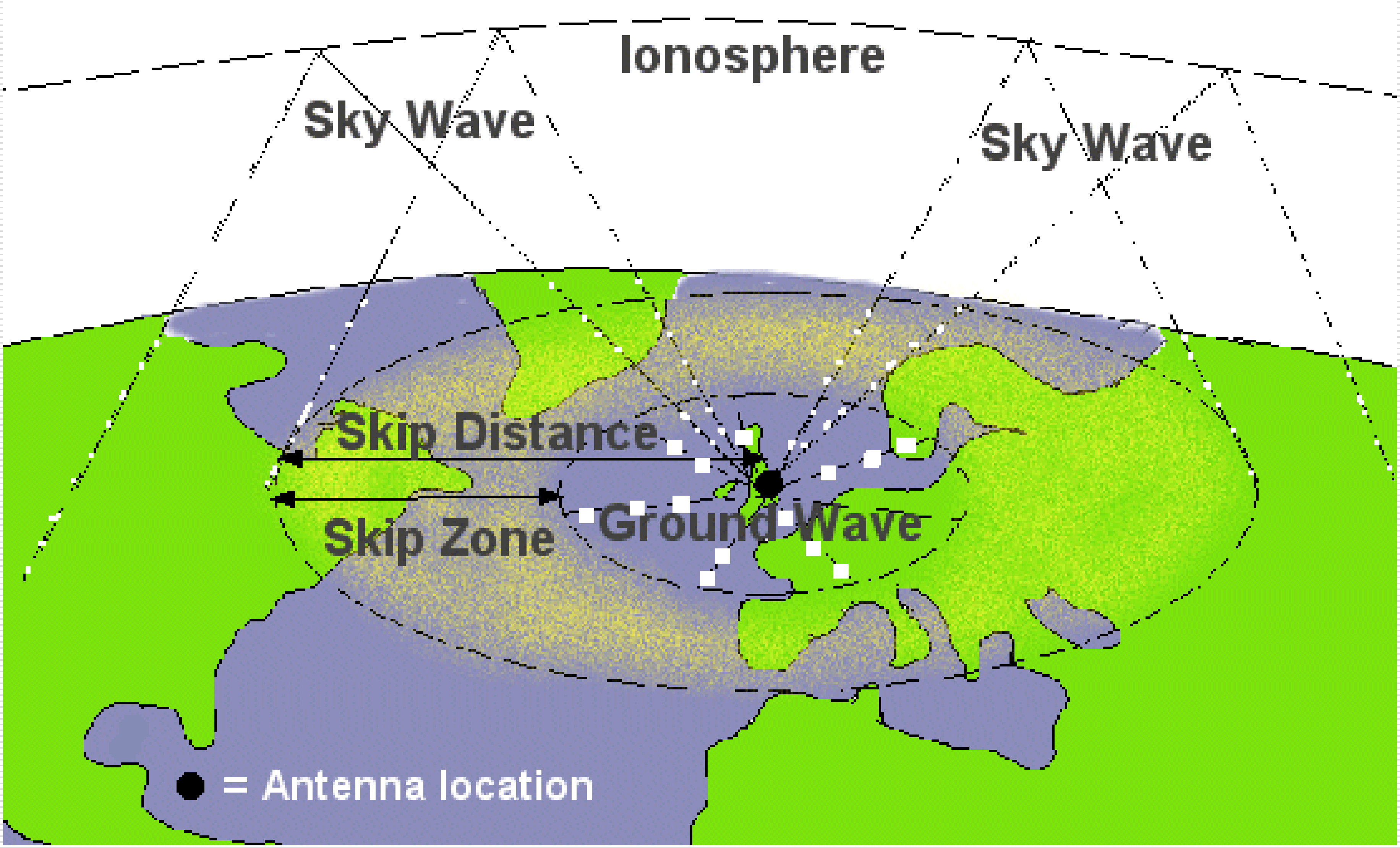
Trail & Error

→ SUCCESSFUL HF COMMUNICATIONS

Basics of RF Propagation

- Propagation
  - Describes how radio signals radiate outward from a transmitting source
- Two basic modes of propagation
  - Ground waves
    - Travel along the surface of the Earth and are used primarily for very short-range communications
    - Consist of three components: surface waves, direct waves, and ground-reflected waves
  - Sky waves
    - Reflected by the ionosphere and "bounced" or reflected back to Earth
    - Provide a long-haul communications path



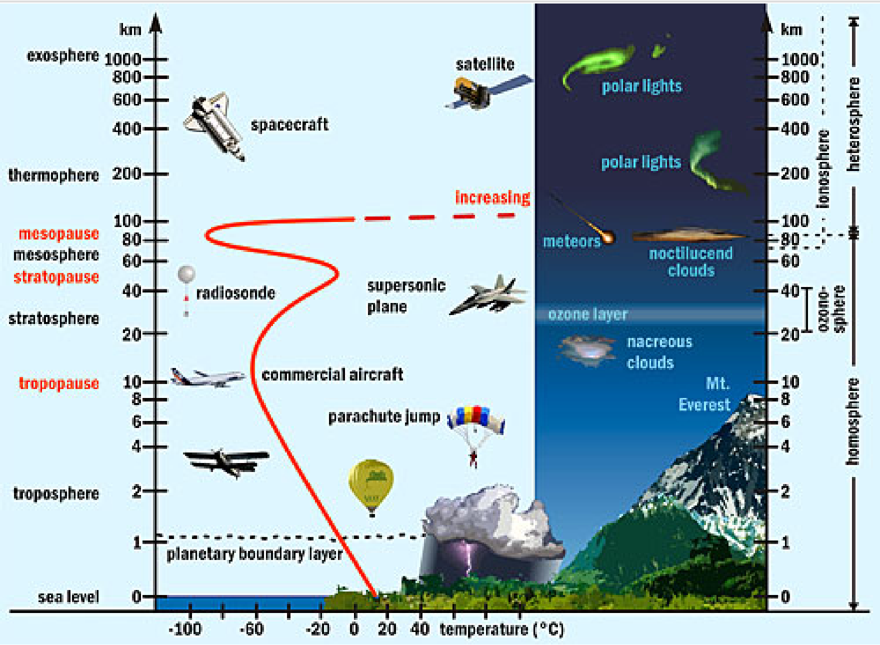

Ionosphere
Sky Wave
Sky Wave
Skip Distance
Skip Zone
Ground Wave
● = Antenna location

Sky wave Propagation

- Radio communications that use sky wave propagation depend on the ionosphere to provide the signal path between the transmitting and receiving antennas
  - Using sky waves can be tricky, since the ionosphere is constantly changing
- At certain frequencies, radio waves are refracted (or bent), returning to Earth hundreds or thousands of miles away
- Signal can bounce several times before reaching a receiver
  - Depending on frequency, time of day (TOD), and atmospheric conditions

Ionosphere

- Region of electrically charged particles or gases in the Earth's atmosphere
  - extending from approximately 50 to 600 km (30 to 375 miles) above the Earth's surface
- Ionization results from solar radiation
  - the process in which electrons are stripped from atoms and produce electrically charged particles
  - If they become highly ionized they may glow and be visible



Why is the ionosphere important in HF radio?

- When radio waves strike these ionized layers, depending on frequency:
  - some are completely absorbed
    - absorption tends to be greater at lower frequencies
    - increases as the degree of ionization increases
  - others are refracted so they return to the Earth
    - incident angle is determined by wavelength (i.e. frequency) and the type and orientation of the transmitting antenna
    - communications with a distant station requires a greater incident angle, while communications with a nearby station requires a smaller incident angle (NVIS)
  - others pass through the ionosphere into outer space

MUF, LUF & FOT

- MUF → Maximum Usable Frequency
  - In radio transmission using reflection from the regular ionized layers of the ionosphere, the upper frequency limit that can be used for transmission between two points at a specified time
  - Operational MUF (or just MUF) is the highest frequency that would permit acceptable operation of a radio service between given terminals at a given time under specific working conditions (antennas, power, emission type, required S/N ratio, and so forth)
  - MUF is the frequency for which ionospheric support is predicted on 50% of the days of the month, i.e. 15 days out of 30 days
    - So on a given day communications may or may not succeed on the frequency marked as the MUF

- LUF →Lowest Usable high Frequency
  - The lowest frequency in the HF band at which the received field intensity is sufficient to provide the required signal-to-noise ratio for a specified time period
    - e.g. , 0100 to 0200 UTC, on 90% of the undisturbed days of the month
  - Amount of energy absorbed by the lower regions (D region, primarily) directly impacts the LUF

- FOT →Frequency of Optimum Transmission
  - In the transmission of radio waves via ionospheric reflection, the highest effective, i.e., working, frequency that is predicted to be usable for a specified path and time for 90% of the days of the month
  - The FOT is normally just below the value of the maximum usable frequency (MUF)
  - In the prediction of usable frequencies, the FOT is commonly taken as 15% below the monthly median value of the MUF for the specified time and path
      - Federal Standard 1037C

“Traditional” HF Propagation Prediction

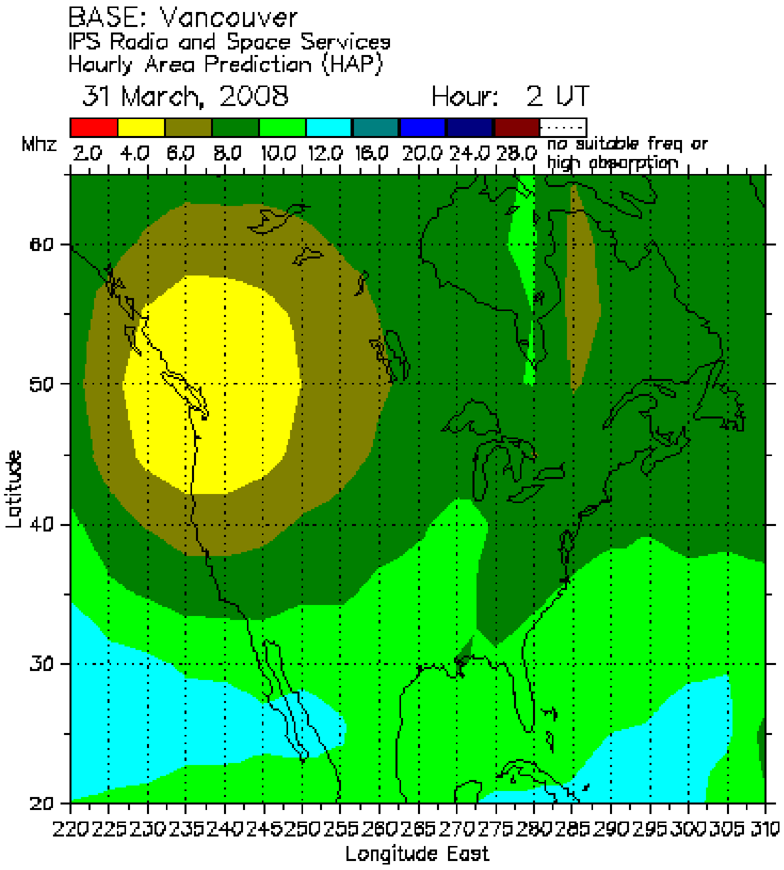
- “Rule of thumb”
  - To ensure a good communication link between two locations, the operating frequency is typically chosen below the predicted MUF
  - A commonly used formula for finding the optimal operating frequency for a given path is to calculate between 80 to 90% of the MUF
- Look it up on the internet
  - MUF, HAP
- “Check the bands”
- Check DX reports
  - DX Reports, Packet Cluster DX Bulletin
- ARRL Propagation Bulletin
- Software Prediction

“Rule of Thumb”

	Band (meter)	MHz	Use*
HF	160	1.8 - 2.0	night
	80	3.5 - 4.0	night and local day
	40	7.0 - 7.3	night and local day
	30	10.1 - 10.15	CW and digital
	20	14.0 - 14.350	world wide day and night
	17	18.068 - 18.168	world wide day and night
	15	21.0 - 21.450	primarily a daytime band
	12	24.890 - 24.990	primarily a daytime band
	10	28.0 - 29.70	daytime during sunspot highs
VHF	6	50 - 54	local to world-wide
	2	144 - 148	local and medium distance
UHF	70 cm	430 - 440	local

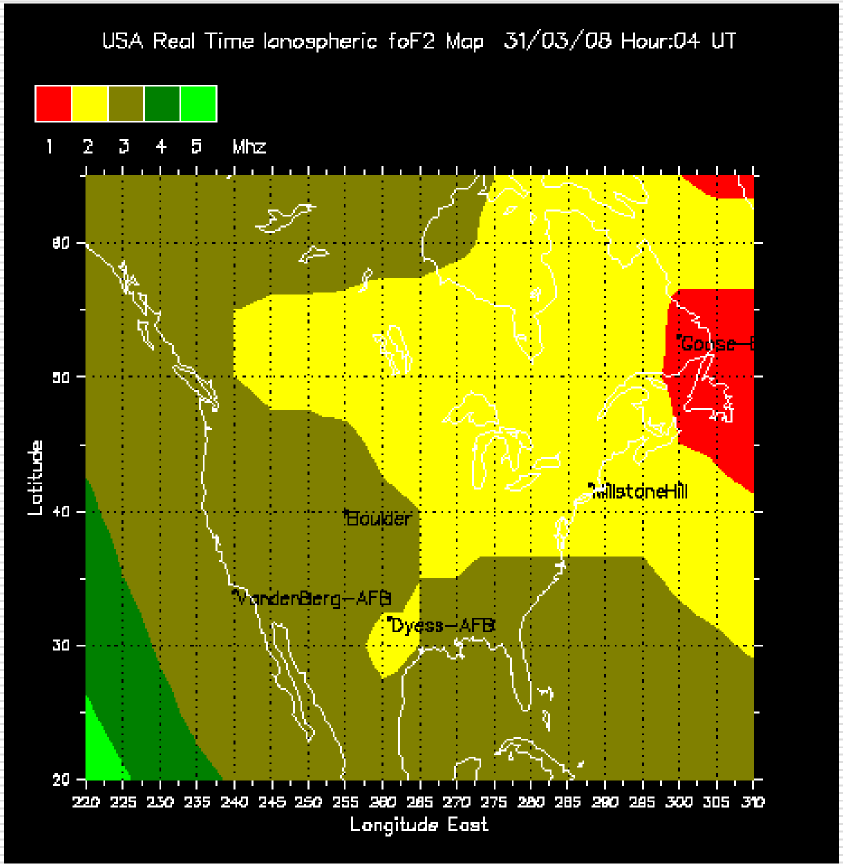
Look it up on the Internet

- The Hourly Area Predictions (HAP) chart is a guide to frequency selection for HF communications between mobiles and a specified base station, in this case Vancouver



Ionospheric Map

- The highest frequency which the ionosphere will reflect vertically is called foF2
- Can be used as a guide to NVIS ionospheric frequency support



Software Prediction

- Two most accepted HF prediction programs in use within the US Government:
  - Ionospheric Communications Enhanced Profile Analysis and Circuit prediction program (ICEPAC)
  - Voice of America Coverage Analysis Program (VOACAP)

Scenario

- Sound Shake scenario occurs
    - All traditional communication methods down
- Local emcomm communications supported via V/UHF
- Short range emcomm comms supported via NVIS
- But emcomm also needs long range HF
    - Health & Welfare
    - Message Traffic

HF Communications

- "WB1XYZ WB1XYZ this is WB7OML, OVER"
  - Voice or CW protocol quickly conveys information:
    - Calling party
    - Called party
    - End of transmission
- ALE works in the same way
  - Calling & called party information
  - Send in standardized ALE frame
    - Allowable ALE words forming an ALE sentence

“Automatic Link Establishment” ??

- First, a definition of ALE:
    - “In high-frequency (HF) radio, the capability of a station to make contact, or initiate a circuit, between itself and another specified radio station, without human intervention and usually under processor control”
    - “Automatic Link Establishment (ALE) is the principle where a specialized radio modem, known as an ALE adaptive controller, is assigned the task of automatically controlling an HF receiver and transmitter in order to establish the highest quality communication link with 1 or multiple HF radio stations[1]”
- The primary purpose of ALE is to provide a much more reliable means for one station to call another station via HF radio
- Adaptive HF describes any HF communications system that has the ability to sense its communications environment, and, if required, to automatically adjust operations to improve communications performance
- ALE Standards:
    - US military (MIL-STD-188-141A/B)
    - Federal Standard (FED-STD-1045A)

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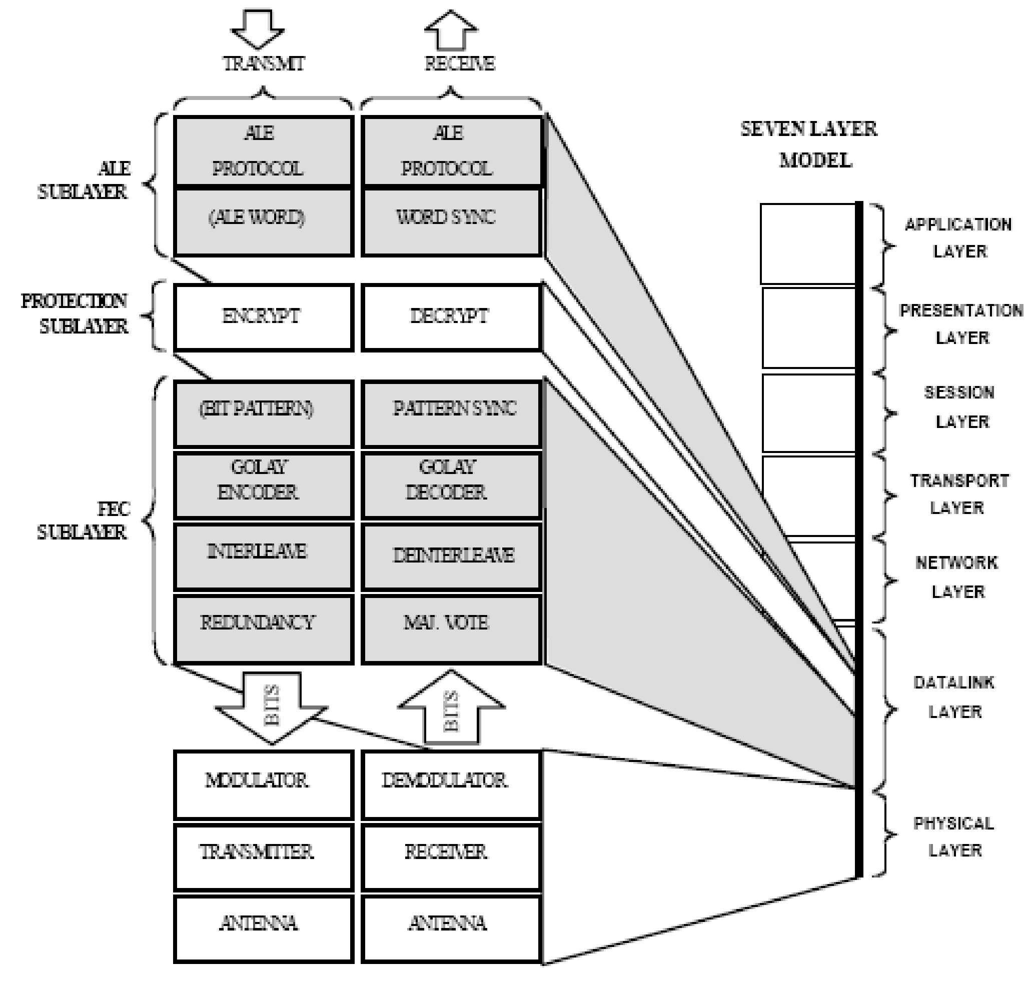
[1] http://www.milspec.ca/modems/ale.html

ALE – the technical details

- Robust communication
- Provides:
  - Signaling techniques
  - Forward error correction
  - Interleaving
  - Redundancy
  - In-band diversity
- 8-ary FSK modulation

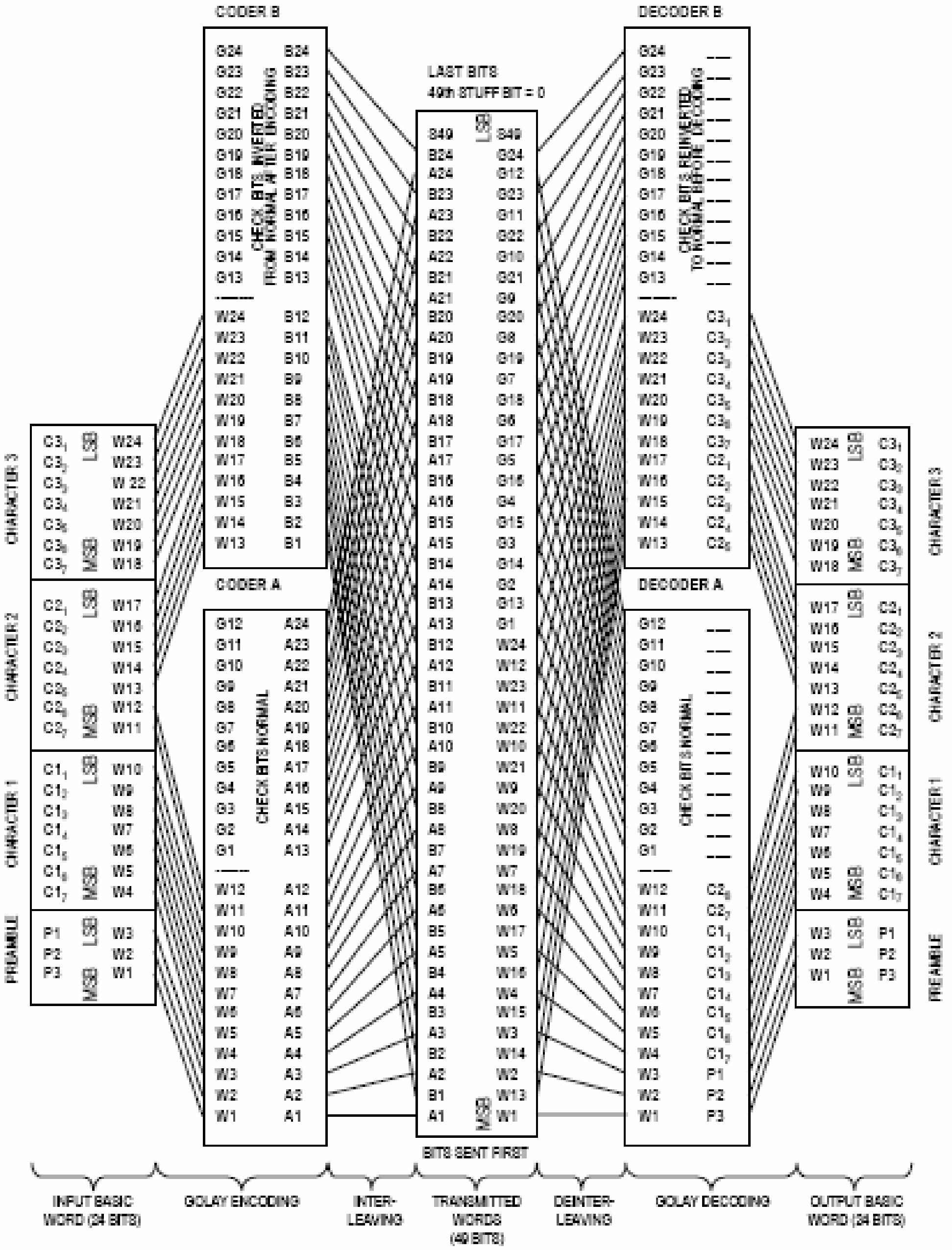
Details will not be covered here!

Protocol Stack



ALE Frames

- ALE Word
  - 24 bits
  - “TO” word
  - “TIS” (“THIS IS”)
  - “TWAS” (“THIS WAS”)
  - “DATA”
  - “REP” (“REPEAT”)
  - “CMD”
  - “FROM”


CODER B
G24 B24
G23 B23
G22 B22
G21 B21
G20 B20
G19 B19
G18 B18
G17 B17
G16 B16
G15 B15
G14 B14
G13 B13
W24 B12
W23 B11
W22 B10
W21 B9
W20 B8
W19 B7
W18 B6
W17 B5
W16 B4
W15 B3
W14 B2
W13 B1
CHECK BITS INVERTED FROM NORMAL AFTER ENCODING
CODER A
G12 A24
G11 A23
G10 A22
G9 A21
G8 A20
G7 A19
G6 A18
G5 A17
G4 A16
G3 A15
G2 A14
G1 A13
W12 A12
W11 A11
W10 A10
W9 A9
W8 A8
W7 A7
W6 A6
W5 A5
W4 A4
W3 A3
W2 A2
W1 A1
CHECK BITS NORMAL
LAST BITS
49th STUFF BIT = 0
LSB
S49 S49
B24 G24
A24 G12
B23 G23
A23 G11
B22 G22
A22 G10
B21 G21
A21 G9
B20 G20
A20 G8
B19 G19
A19 G7
B18 G18
A18 G6
B17 G17
A17 G5
B16 G16
A16 G4
B15 G15
A15 G3
B14 G14
A14 G2
B13 G13
A13 G1
B12 W24
A12 W12
B11 W23
A11 W11
B10 W22
A10 W10
B9 W21
A9 W9
B8 W20
A8 W8
B7 W19
A7 W7
B6 W18
A6 W6
B5 W17
A5 W5
B4 W16
A4 W4
B3 W15
A3 W3
B2 W14
A2 W2
B1 W13
A1 W1
MSB
BITS SENT FIRST
DECODER B
G24 —
G23 —
G22 —
G21 —
G20 —
G19 —
G18 —
G17 —
G16 —
G15 —
G14 —
G13 —
W24 $C3_1$
W23 $C3_2$
W22 $C3_3$
W21 $C3_4$
W20 $C3_5$
W19 $C3_6$
W18 $C3_7$
W17 $C2_1$
W16 $C2_2$
W15 $C2_3$
W14 $C2_4$
W13 $C2_5$
CHECK BITS REINVERTED TO NORMAL BEFORE DECODING
DECODER A
G12 —
G11 —
G10 —
G9 —
G8 —
G7 —
G6 —
G5 —
G4 —
G3 —
G2 —
G1 —
W12 $C2_6$
W11 $C2_7$
W10 $C1_1$
W9 $C1_2$
W8 $C1_3$
W7 $C1_4$
W6 $C1_5$
W5 $C1_6$
W4 $C1_7$
W3 P1
W2 P2
W1 P3
CHECK BITS NORMAL
CHARACTER 3
$C3_1$ LSB W24
$C3_2$ W23
$C3_3$ W 22
$C3_4$ W21
$C3_5$ W20
$C3_6$ W19
$C3_7$ MSB W18
CHARACTER 2
$C2_1$ LSB W17
$C2_2$ W16
$C2_3$ W15
$C2_4$ W14
$C2_5$ W13
$C2_6$ W12
$C2_7$ MSB W11
CHARACTER 1
$C1_1$ LSB W10
$C1_2$ W9
$C1_3$ W8
$C1_4$ W7
$C1_5$ W6
$C1_6$ W5
$C1_7$ MSB W4
PREAMBLE
P1 LSB W3
P2 W2
P3 MSB W1
W24 LSB $C3_1$
W23 $C3_2$
W22 $C3_3$
W21 $C3_4$
W20 $C3_5$
W19 $C3_6$
W18 MSB $C3_7$
CHARACTER 3
W17 LSB $C2_1$
W16 $C2_2$
W15 $C2_3$
W14 $C2_4$
W13 $C2_5$
W12 $C2_6$
W11 MSB $C2_7$
CHARACTER 2
W10 LSB $C1_1$
W9 $C1_2$
W8 $C1_3$
W7 $C1_4$
W6 $C1_5$
W5 $C1_6$
W4 MSB $C1_7$
CHARACTER 1
W3 LSB P1
W2 P2
W1 MSB P3
PREAMBLE
INPUT BASIC WORD (24 BITS)
GOLAY ENCODING
INTER-LEAVING
TRANSMITTED WORDS (49 BITS)
DEINTER-LEAVING
GOLAY DECODING
OUTPUT BASIC WORD (24 BITS)

Synchronization at the Receiver

- When receiver is on a frequency carrying ALE signaling
  - Receiving demodulator first achieves signal synchronization with the transmitting modulator
  - Provides recovered data to the decoder
- Decoder performs de-interleaving and FEC decoding
- Achieve word synchronization

ALE Tones

- The ALE transmission tones sound unique and strange when you first hear them
- The continuous warbling-tone calling sequence lasts about 20 to 90 seconds during the initial linking progress
- Examples audio files available at:
  - http://www.milspec.ca/modems/ale.html

Definitions

- Available State
  - An ALE controller is in the available state when it does not currently have a link with any other station, and is not in the process of establishing a link
  - An ALE controller that is programmed for multichannel scanning operation will be scanning when it is in the available state
- Linking State
  - An ALE controller enters the linking state from the available state when it sends or receives an ALE call frame
  - Scanning controllers stop scanning when they enter the linking state
  - An ALE controller returns to the available state if the linking attempt does not complete successfully
  - Upon successful completion of a three-way handshake, controllers in the linking state enter the linked state
- Linked State.
  - An ALE controller is considered to be in the linked state if it has successfully completed link establishment with one or more stations, and at least one link to which it is party has not been terminated. While in the linked state, a wait-for-activity timer will be running (if not disabled by the operator)
  - Controllers programmed to scan will not be scanning while in the linked state
  - After link establishment, communication among linked stations normally is carried by additional three-way handshakes, but controllers remain in the linked state during these handshakes

Link Establishment States

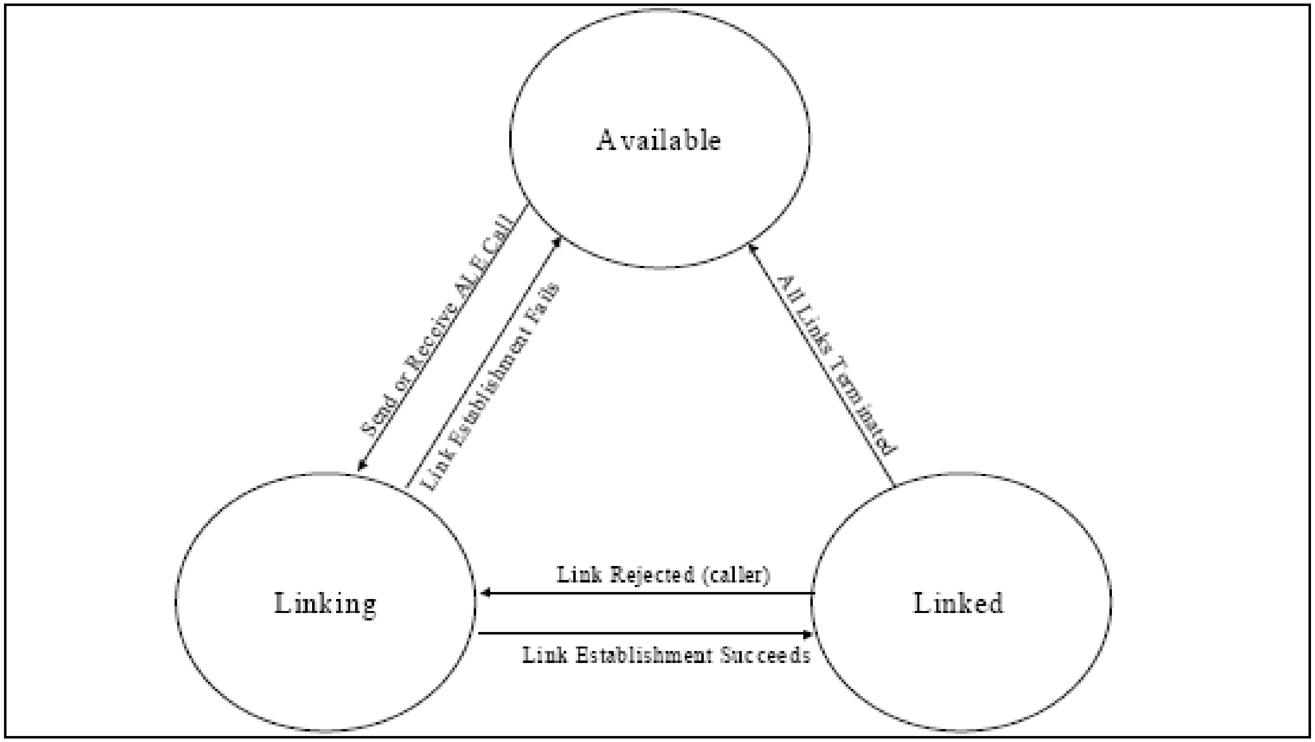
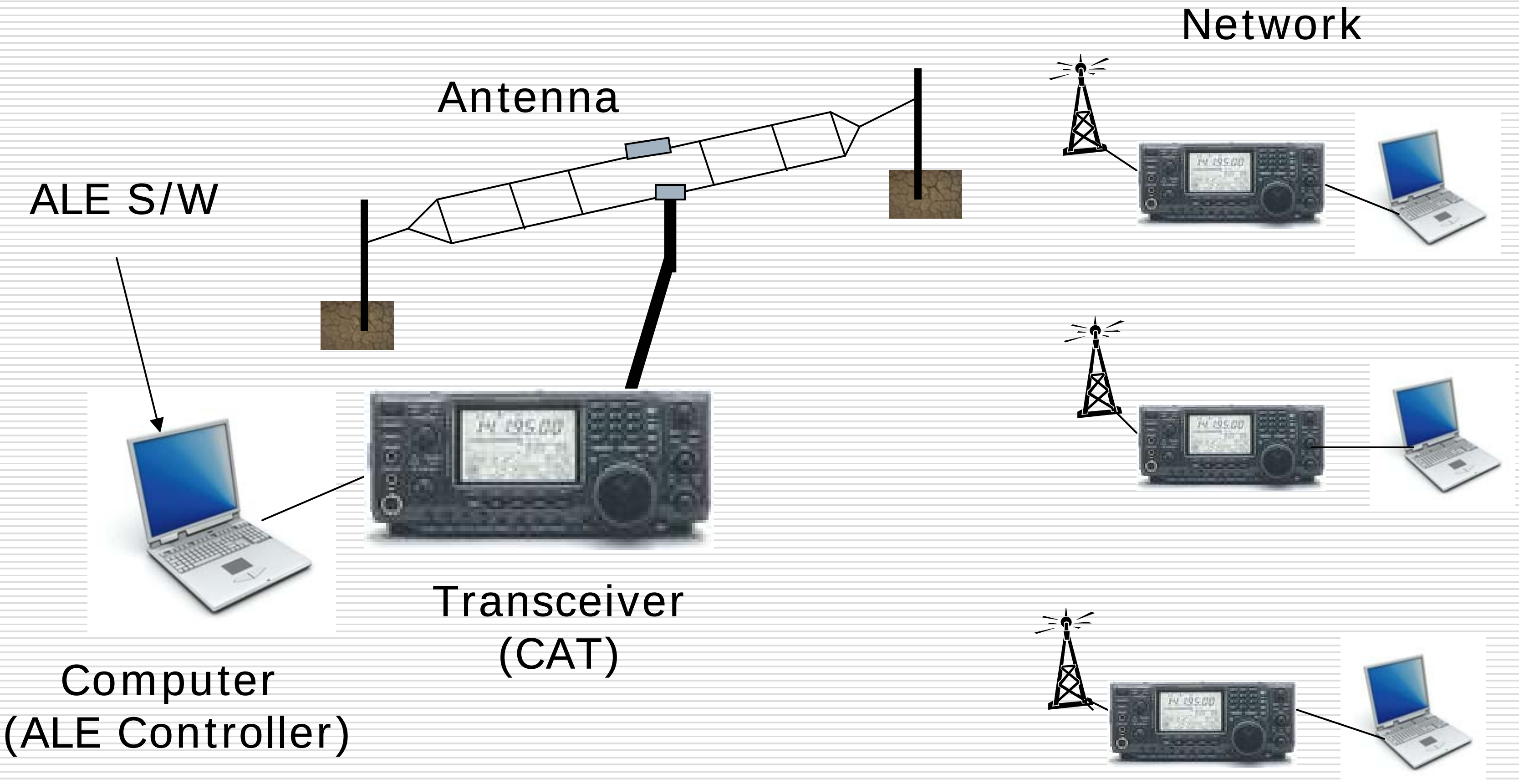


FIGURE A-28. Link establishment states.

Components of an ALE System



ALE S/W

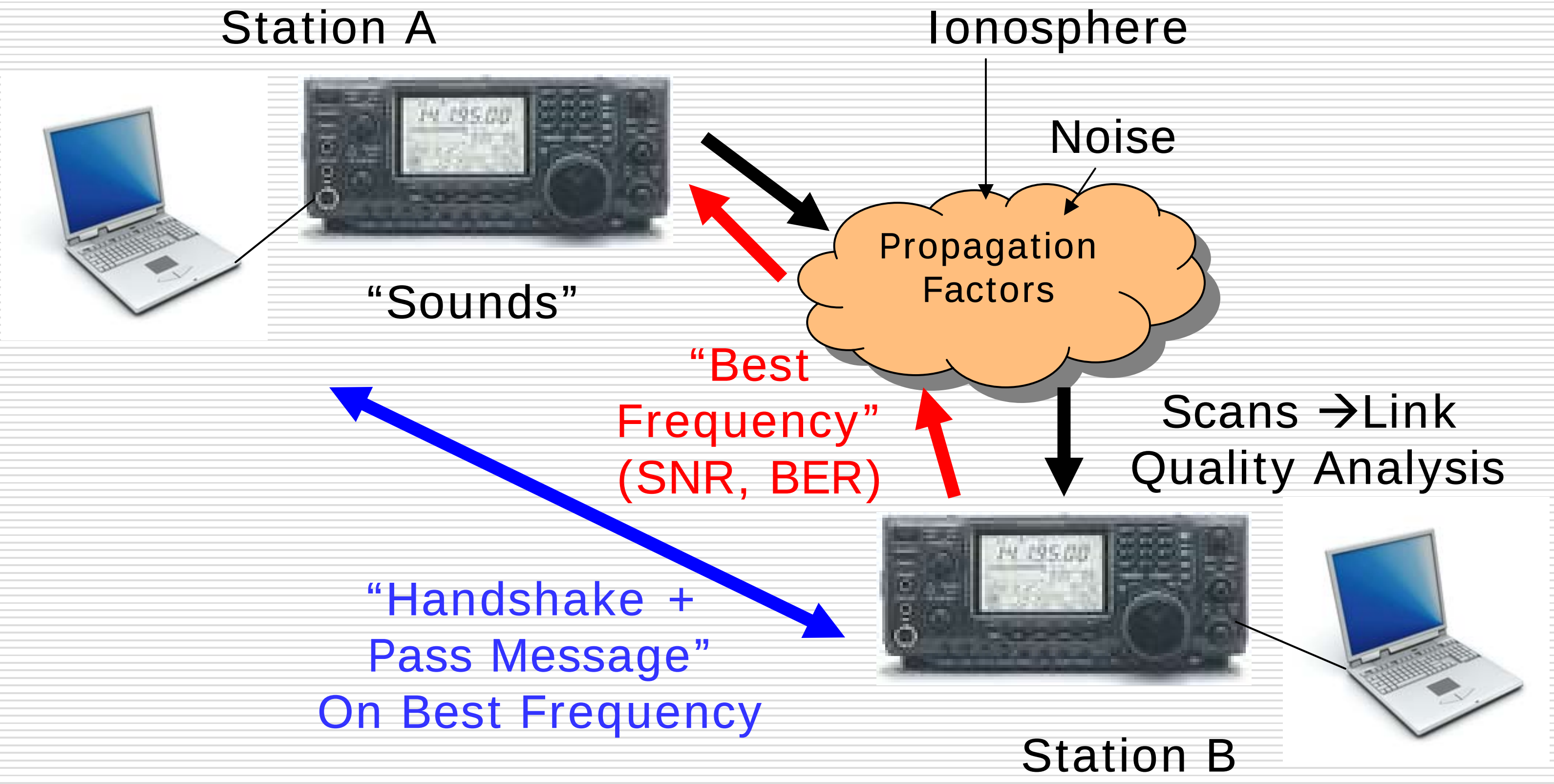
Antenna

Network

Transceiver
(CAT)

Computer
(ALE Controller)

Typical ALE Link Set-up



Station A

Ionosphere

Noise

Propagation Factors

"Sounds"

"Best Frequency" (SNR, BER)

Scans →Link Quality Analysis

"Handshake + Pass Message" On Best Frequency

Station B

ALE Linking Sequence

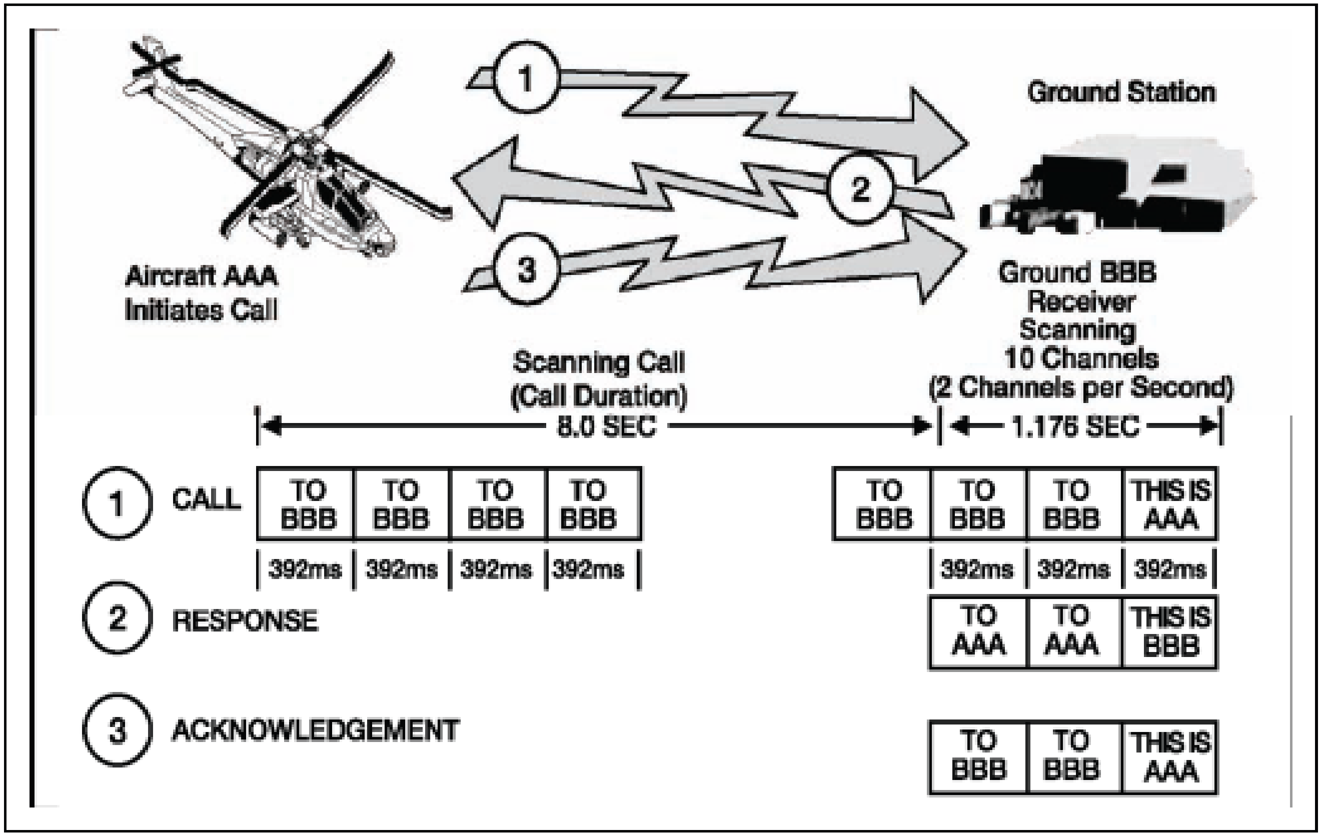


Figure II-1. ALE Linking Sequence

What do you need to make ALE work?

- Channel Assignments

- Net Members
  - Net configuration can be based on the distance the stations are from one another
  - Example →
    - a sub-group of stations that all need to communicate with a common station that is some distance away
    - special group of net channel frequencies that will more likely support the geographic distance between the subgroup of stations and the primary station
  - All radios in the net will have all net members listed in a look-up table in a specific order
  - Allows a "NET-Call“ where all members of the called net will respond back to the calling station during a specifically-defined time slot
  - Each station has it's own "Self-Address" or callsign which identifies it's station to other net members
  - Each NET has a "NET Address". Net addresses are used for "NET Calls" where a station wants to call, and communicate with, all stations assigned to the net.
  - "ANY Calls" → calling station wants to make contact with any station on the frequency which has an ALE address, whether the called station is a member of the assigned net or not
    - The calling station does not have to have the called station's ALE address in their membership list

Scanning

- The radio system shall be capable of repeatedly scanning selected channels stored in memory (in the radio or controller) under either manual control or under the direction of any associated automated controller
- The radio shall stop scanning and wait on the most recent channel upon the occurrence of any of the following selectable events:
  - Automatic controller decision to stop scan (the normal mode of operation)
  - Manual input of stop scan
  - Activation of external stop-scan line (if provided)
- The scanned channels should be selectable by:
  - Groups (often called “scan lists”)
  - Individually within the groups, to enable flexibility in channel and network scan management

Scanning

- When ALE stations are not passing traffic
  - Scan a pre-selected set of channels listening for your call sign
- Scan rates can be 2 or 5 channels/second
  - Most units can scan up to 100 channels at two to five channels per second
- All stations in the network need to be on the same frequencies
- When ALE data burst is detected, stop scanning and decode data burst to see if your station is being called

What Frequencies do I Scan?

- For ALE to function properly, frequency selection is important
- When selecting frequencies to use in a network, take into consideration the times of operation and distances to be communicated, power level used, type of antenna(s) used and so forth
- When using the above parameters, a good propagation program should also be used to determine which frequencies are best

Sounding

- Periodic broadcast message sent out
  - Contains your call sign
  - Rate determined by level of activity & maximum acceptable probability that you have the recent sounds
- Receiving station(s) store the call sign and link quality information in a table
- Sounding data can be used to contact station in future time

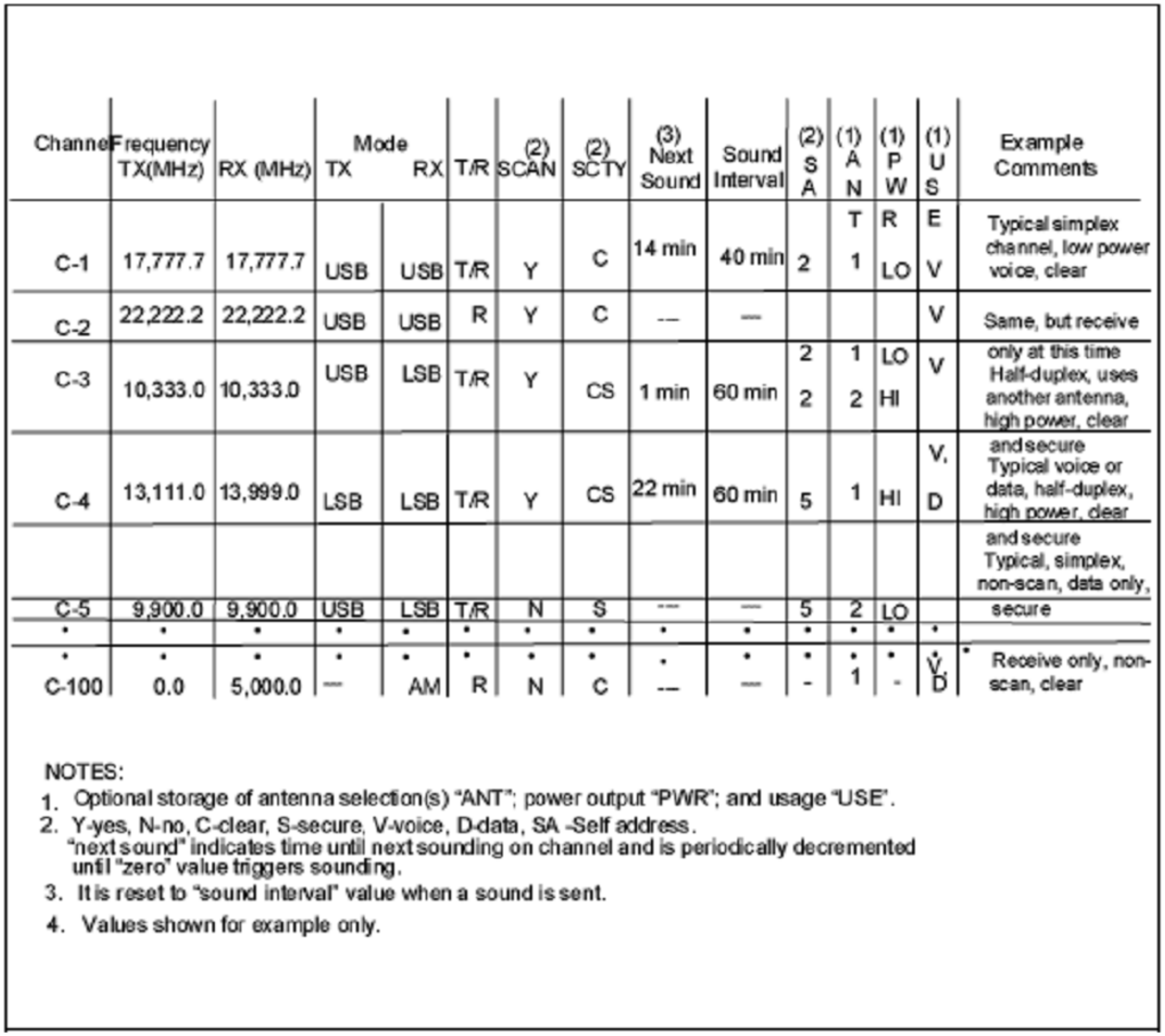
Link Quality Analysis (LQA)

- Link quality analysis is an automatic measure of the signal quality between two stations based on bit error rate (BER) and signal-to-noise and distortion (SINAD)
- The LQA memory is built up by passive or active measurements of short-term channel quality on designated frequencies
- The active measurement employs special transmissions called sounding
- This gives the listening stations a chance to measure channel quality at scheduled time intervals

Sounding Table

- The mode information normally includes:
  - transmit power level
  - traffic or channel use (voice, data, etc.)
  - sounding data
  - modulation type (associated with frequency)
  - transmit/receive modes
  - filter width (DO)
  - automatic gain control (AGC) setting (DO)
  - input/output antenna port selection (DO)
  - input/output information port selection (DO)
  - noise blanker setting (DO)
  - security (DO)
  - sounding self address(es) SA....n(DO)

Sounding Table Example



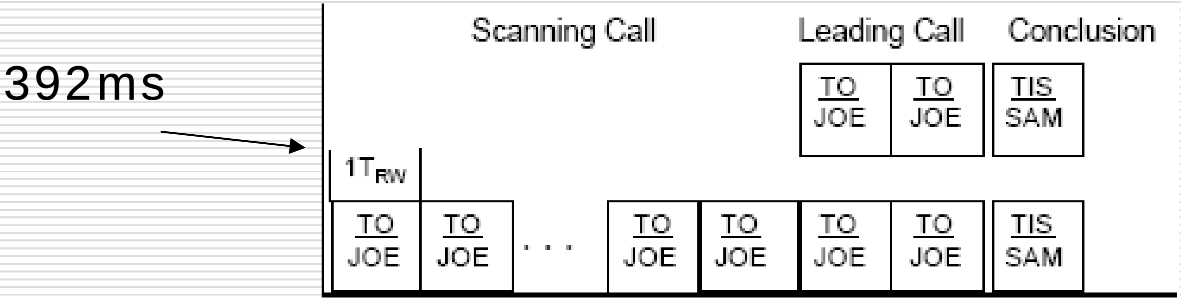
Channel	Frequency TX(MHz)	RX (MHz)	Mode TX	RX	T/R	(2) SCAN	(2) SCTY	(3) Next Sound	Sound Interval	(2) SA	(1) ANT	(1) PWR	(1) USE	Example Comments
C-1	17,777.7	17,777.7	USB	USB	T/R	Y	C	14 min	40 min	2	1	LO	V	Typical simplex channel, low power voice, clear
C-2	22,222.2	22,222.2	USB	USB	R	Y	C	--	—				V	Same, but receive only at this time
C-3	10,333.0	10,333.0	USB	LSB	T/R	Y	CS	1 min	60 min	2 2	1 2	LO HI	V	Half-duplex, uses another antenna, high power, clear and secure
C-4	13,111.0	13,999.0	LSB	LSB	T/R	Y	CS	22 min	60 min	5	1	HI	V, D	Typical voice or data, half-duplex, high power, clear and secure
C-5	9,900.0	9,900.0	USB	LSB	T/R	N	S	---	—	5	2	LO		Typical, simplex, non-scan, data only, secure
•	•	•	•	•	•	•	•	•	•	•	•	•	•	
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
C-100	0.0	5,000.0	—	AM	R	N	C	--	—	-	1	-	V, D	Receive only, non-scan, clear

NOTES:

1. Optional storage of antenna selection(s) "ANT"; power output "PWR"; and usage "USE".
2. Y-yes, N-no, C-clear, S-secure, V-voice, D-data, SA -Self address.
   "next sound" indicates time until next sounding on channel and is periodically decremented until "zero" value triggers sounding.
3. It is reset to "sound interval" value when a sound is sent.
4. Values shown for example only.

ALE Call

- One-to-one call
- One-to-many call
  - Net calling
  - Group calling
- Any call



ALE Messaging

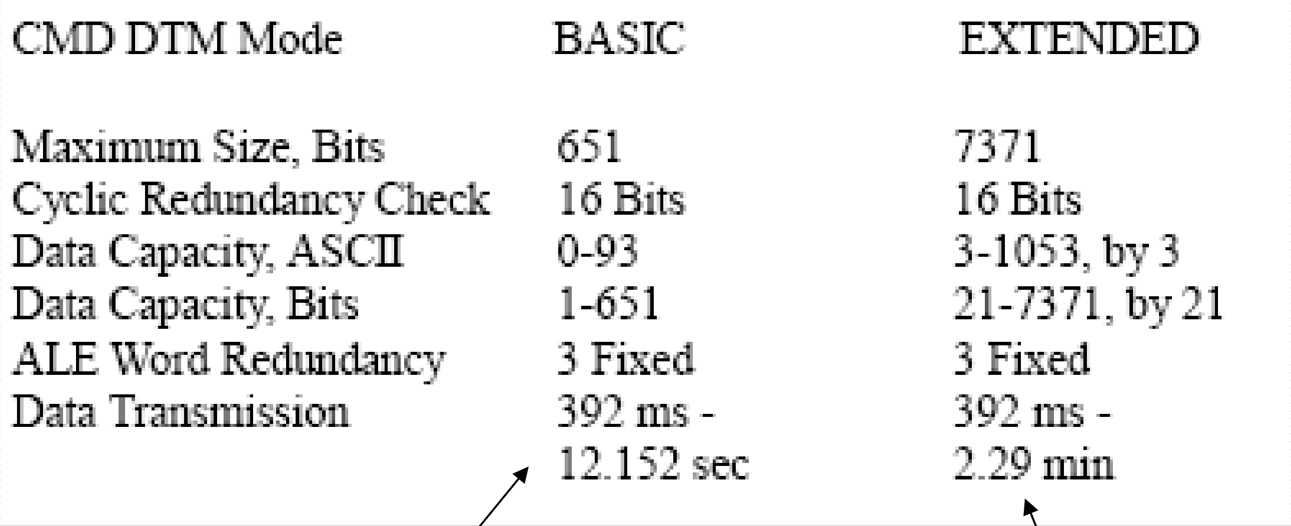
- Can send messages to other stations via the ALE modem
  - Automatic Message Display (AMD) - 90 character limit
  - Data Text Messages (DTM) - ASCII
  - Data Block Messages (DBM) - binary
- Low data rate
- “CMD AMD” word

AMD

- Any quantity of AMD words may be sent within the message section of the frame within the Tm max limitation of 30 words
  - 90 characters
- Message section basic time:
  - Tm max basic = 11.76s

8 characters / second

DTM Characteristics

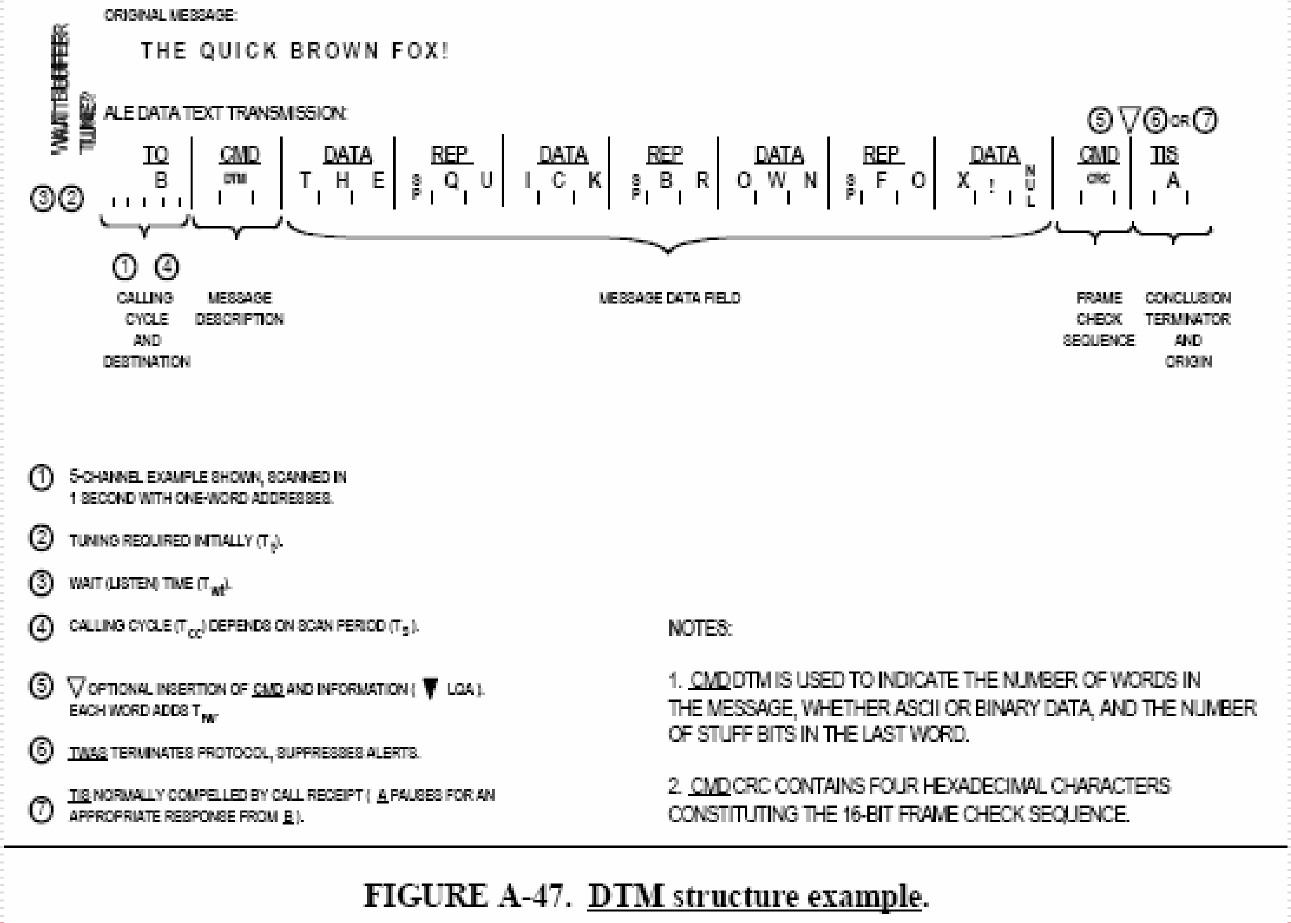


CMD DTM Mode	BASIC	EXTENDED
Maximum Size, Bits	651	7371
Cyclic Redundancy Check	16 Bits	16 Bits
Data Capacity, ASCII	0-93	3-1053, by 3
Data Capacity, Bits	1-651	21-7371, by 21
ALE Word Redundancy	3 Fixed	3 Fixed
Data Transmission	392 ms - 12.152 sec	392 ms - 2.29 min

54 bps

50 bps

DTM Example



① 5-CHANNEL EXAMPLE SHOWN, SCANNED IN 1 SECOND WITH ONE-WORD ADDRESSES.

② TUNING REQUIRED INITIALLY (T_t).

③ WAIT (LISTEN) TIME (T_{wt}).

④ CALLING CYCLE (T_{cc}) DEPENDS ON SCAN PERIOD (T_S).

⑤ ▽ OPTIONAL INSERTION OF CMD AND INFORMATION (▼ LQA). EACH WORD ADDS T_{rw}.

⑥ TWAS TERMINATES PROTOCOL, SUPPRESSES ALERTS.

⑦ TIS NORMALLY COMPELLED BY CALL RECEIPT (A PAUSES FOR AN APPROPRIATE RESPONSE FROM B).

NOTES:

1. CMD DTM IS USED TO INDICATE THE NUMBER OF WORDS IN THE MESSAGE, WHETHER ASCII OR BINARY DATA, AND THE NUMBER OF STUFF BITS IN THE LAST WORD.

2. CMD CRC CONTAINS FOUR HEXADECIMAL CHARACTERS CONSTITUTING THE 16-BIT FRAME CHECK SEQUENCE.

FIGURE A-47. DTM structure example.

ALE Protocol

- All stations on the net, not actually in use, will be scanning assigned net channels, looking for calls from other stations or monitoring for sounding messages
- When a station is not linked, sounding messages can be sent either manually, or at predetermined intervals of:
  - 30 minutes
  - 60 minutes
  - 90 minutes
  - 120 minutes
- All stations, whether linked or unlinked status, always have their ALE modems monitoring the frequency that the radio is currently tuned
  - This allows the radio, whether actively engaged in a conversation or not, to decode sounding messages
- Will not interfere with active channel carrying detectable traffic in (unless this listen call function is overriden by the operator or other controller)
- Always will exchange LQA with other stations when requested (unless inhibited), and always measures the signal quality of others
- Will respond in the appropriate time slot to calls requiring slotted responses
- Always seek (unless inhibited) and maintain track of their connectivities with others
- Minimize transmit and receive time on channel
- Automatically minimize power used (if capable)

ALE Parameters

- Address
  - This parameter assigns a unique call sign or address to each radio
- ALL Call
  - This parameter determines if the radio will respond to an “ALL” Call
  - An ALL Call attempts to link with all the ALE stations using a broadcast format
- AMD Allowed, Auto Display AMD
  - This parameter enables (or disables) the ability of the radio to receive AMD messages and enables (or disables) the ability of the radio to display a received AMD message on its front panel
  - If this is turned off, your radio will not receive and store AMD messages sent to it
- ANY Call
  - This parameter determines if the radio will respond to an “ANY” Call
  - An ANY Call attempts to link with all ALE stations in the same manner as with the ALL Call, except the individual stations are expected to respond at one of 16 random intervals for linking purposes
- Scan Set (AKA Channel Group or Scan List)
  - This parameter groups individual channels together for use in an ALE network
- LQA in Call
  - This parameter enables (or disables) a feature that forces the radio to do an LQA before attempting an ALE call
- Maximum Tune Time
  - This parameter sets the length of time the calling station waits for the target station to tune its antenna coupler and power amplifier and respond to the call

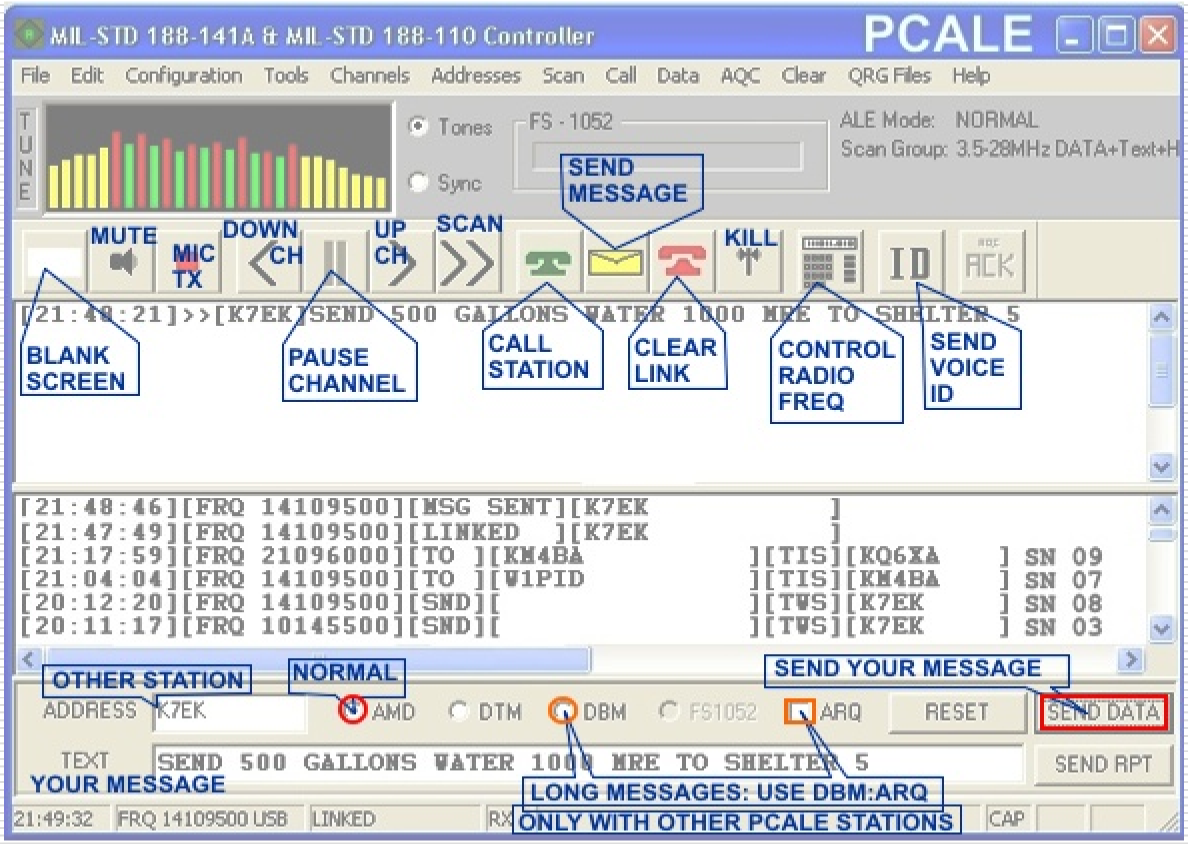
Amateur ALE Requirements

- HFLINK ALE User Group
  - www.hflink.com
- PCALE Software
  - Charles Brain, G4GAO
- Modern Computer-controlled Transceiver
- Wideband Antenna
  - With Automatic Tuner

PCALE

- Full Mil-Standard Automatic Link Establishment operation using HF SSB or ham radio transceivers
- Advanced features include:
  - Scanning
  - Sounding
  - Channel Groups
  - Calling
  - Netcalls
  - Allcalls
  - AMD
  - DBM
  - DTM
  - LQA
- Use with a PC sound device and CAT control interface
- High speed PSK ARQ HF modem included
- User supported by HFLINK Group
- Free for ham radio use

PCALE



ALE Mode: NORMAL

Scan Group: 3.5-28MHz DATA+Text+H

```
[21:48:21]>>[K7EK]SEND 500 GALLONS WATER 1000 MRE TO SHELTER 5
```

```
[21:48:46][FRQ 14109500][MSG SENT][K7EK                    ]
[21:47:49][FRQ 14109500][LINKED  ][K7EK                    ]
[21:17:59][FRQ 21096000][TO ][KM4BA                    ][TIS][KQ6XA    ] SN 09
[21:04:04][FRQ 14109500][TO ][W1PID                    ][TIS][KM4BA    ] SN 07
[20:12:20][FRQ 14109500][SND][                         ][TWS][K7EK     ] SN 08
[20:11:17][FRQ 10145500][SND][                         ][TWS][K7EK     ] SN 03
```

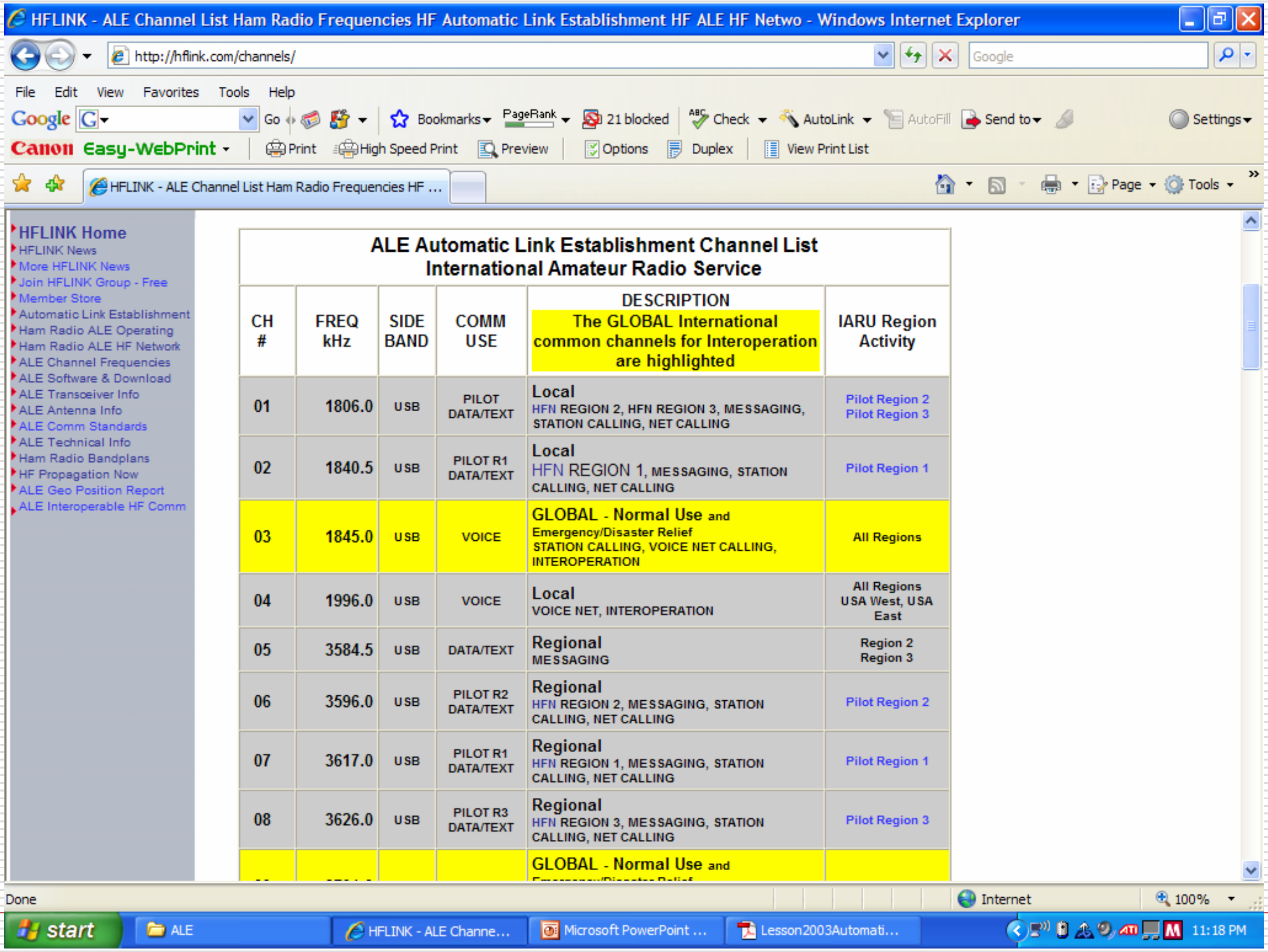
ADDRESS K7EK

● AMD ○ DTM ○ DBM ○ FS1052 ☐ ARQ

TEXT SEND 500 GALLONS WATER 1000 MRE TO SHELTER 5

21:49:32 | FRQ 14109500 USB | LINKED | RX

ALE Channel List



ALE Automatic Link Establishment Channel List
International Amateur Radio Service

CH #	FREQ kHz	SIDE BAND	COMM USE	DESCRIPTION The GLOBAL International common channels for Interoperation are highlighted	IARU Region Activity
01	1806.0	USB	PILOT DATA/TEXT	Local HFN REGION 2, HFN REGION 3, MESSAGING, STATION CALLING, NET CALLING	Pilot Region 2 Pilot Region 3
02	1840.5	USB	PILOT R1 DATA/TEXT	Local HFN REGION 1, MESSAGING, STATION CALLING, NET CALLING	Pilot Region 1
03	1845.0	USB	VOICE	GLOBAL - Normal Use and Emergency/Disaster Relief STATION CALLING, VOICE NET CALLING, INTEROPERATION	All Regions
04	1996.0	USB	VOICE	Local VOICE NET, INTEROPERATION	All Regions USA West, USA East
05	3584.5	USB	DATA/TEXT	Regional MESSAGING	Region 2 Region 3
06	3596.0	USB	PILOT R2 DATA/TEXT	Regional HFN REGION 2, MESSAGING, STATION CALLING, NET CALLING	Pilot Region 2
07	3617.0	USB	PILOT R1 DATA/TEXT	Regional HFN REGION 1, MESSAGING, STATION CALLING, NET CALLING	Pilot Region 1
08	3626.0	USB	PILOT R3 DATA/TEXT	Regional HFN REGION 3, MESSAGING, STATION CALLING, NET CALLING	Pilot Region 3
				GLOBAL - Normal Use and	

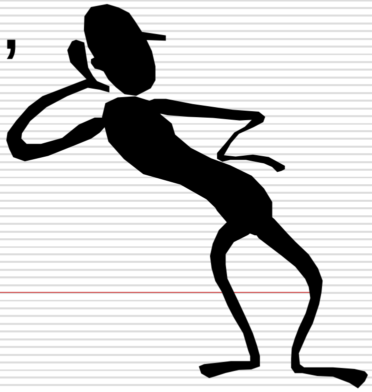
Source: http://hflink.com

International Amateur Radio ALE Network Channel List

- CH# FREQ kHz SIDEBAND COMM USE DESCRIPTION IARU REGION
- ----
- 01- 1806.0 USB VOICE/DATA IARU R2,3 (Sounding R2,3)
- 02- 1840.5 USB VOICE/DATA IARU R1 (Sounding R1)
- 03- 1845.0 USB VOICE/DATA IARU R1,2,3
- 04- 1996.0 USB VOICE/DATA IARU R1,2,3
- 05- 3596.0 USB DATA/VOICE IARU R1,2,3 (Sounding R2)
- 06- 3617.0 USB DATA/VOICE IARU R1,3 (Sounding R1)
- 07- 3626.0 USB DATA/VOICE IARU R1 (Sounding R3)
- 08- 3791.0 USB VOICE =COMMON ALL IARU REGIONS=
- 09- 3996.0 USB VOICE IARU R2
- 10- 5371.5 USB VOICE IARU R1,3 (Emergency R2*)
- 11- 5403.5 USB VOICE IARU R1,3 (Emergency R2*)
- 12- 7030.5 USB DATA IARU R3 Asia (Sounding R3)
- 13- 7040.5 USB DATA IARU R1 (Sounding R1)
- 14- 7065.0 USB DATA/VOICE IARU R1,3
- 15- 7102.0 USB DATA/VOICE IARU R1,2,3 (Sounding R2)
- 16- 7185.5 USB VOICE =COMMON ALL IARU REGIONS
- 17- 7296.0 USB VOICE IARU R2,3
- 18- 10136.5 USB DATA/VOICE IARU R1,2,3
- 19- 10145.5 USB DATA =COMMON ALL IARU REGIONS(Sounding R1,2,3)
- 20- 14100.5 USB DATA IARU R1,2,3
- 21- 14109.5 USB DATA =COMMON ALL IARU REGIONS(Sounding R1,2,3)
- 22- 14342.5 USB VOICE =COMMON ALL IARU REGIONS
- 23- 14346.0 USB VOICE =COMMON ALL IARU REGIONS
- 24- 18106.0 USB DATA IARU R1,2,3 (Sounding R2,3)
- 25- 18117.5 USB VOICE/DATA =COMMON ALL IARU REGIONS(SoundingR1)
- 26- 18157.5 USB VOICE =COMMON ALL IARU REGIONS
- 27- 21117.5 USB DATA IARU R1,2,3 (Sounding R1,3)
- 28- 21157.5 USB DATA IARU R1,2,3 (Sounding R2)
- 29- 21437.5 USB VOICE =COMMON ALL IARU REGIONS
- 30- 24926.0 USB DATA IARU R1,2,2 (Sounding R1,2,3)
- 31- 24977.5 USB VOICE =COMMON ALL IARU REGIONS
- 32- 28117.5 USB DATA IARU R1,2,3 (Sounding R1)
- 33- 28146.0 USB DATA IARU R1,2,3 (Sounding R2,3)
- 34- 28327.5 USB VOICE =COMMON ALL IARU REGIONS
- 35- 50162.5 USB VOICE/DATA IARU R1,2,3 (Sounding R1,2,3)
- 36- 144162.5 USB VOICE/DATA IARU R1,2,3 (Sounding R1,2,3)

Amateur Radio ALE

- Each amateur radio ALE station uses the operator's callsign as an address in the ALE controller
- When not actively in a QSO with another station, each HF SSB transceiver constantly scans through a list of frequencies (*channels*), listening for its callsign



Amateur Radio ALE QSO

- To contact a specific station, the caller simply enters the callsign into the ALE controller just like dialing a phone number
- The ALE controller selects the best available frequency and sends out brief selective calling signals containing the callsigns
- When the distant scanning station detects the first few characters of its callsign, it stops scanning and stays on that frequency
- The two stations' ALE controllers automatically handshake to confirm that a link is established and they are ready to communicate
- The receiving station, which was muted up until now, will typically emit an audible alarm and visual alert for the receiving operator of the incoming call
  - It also indicates the callsign of the linked station
- The operators then can talk in a regular QSO
- At the conclusion of the QSO, one of the stations sends a disconnect signal to the other station
- They each return their ALE stations to the scanning mode

Amateur Radio ALE Standards

- ALE System = MIL-STD 188-141 ; FED-1045 (8FSK, 2.2kHzBW)
- Call or Sounding transmission duration: 30 seconds or less.
- Scan rate: 1 or 2 channels per second.
- Sounding Interval = 60 Minutes (or more) (for same channel)
- CQ Call = NETCALL to "HFL" net (or "QRZ" on sounding channels)
- Digi Texting Audio Centre Frequency= 1500HZ (to 1800HZ)
- Short text messaging standard = AMD
- TWS SOUNDING (Recommended)
- "TWS" is always sent to clear link after ALLCALLS or LINKING

Amateur Radio ALE Netcalls

- HFL = CQ, ALL AMATEUR RADIO ALE STATIONS
- HAM = EMERGENCY LIASON NET: AMATEUR TO GOV
- GPR = GEO POSITION REPORTS
- RPT = STATION STATUS REPORTS
- QRZ = OPEN RESPONSE NET ON SOUNDING CHANNELS
- CQA = RESERVED FOR FUTURE USE

Amateur ALE Timing Standards

- Tune Time (TT) max = 1 second (or 1045mSec)
- Time Wait for Reply (TWR) max = 2 seconds (or 2048mSec)
- Link Quality Analysis (LQA) time out = 3 hours (or 180 minutes)
- Linked PTT Inactivity (TWA) time out = 6 minutes (or 360 seconds)

Amateur Global ALE HF Network

- The Global ALE High Frequency Network (HFN) is a system of ALE base stations with internet connectivity
- Each HFN Pilot Station is rapidly scanning the ALE Pilot Channels of the ham bands 3.5 to 28MHz every 10 seconds, and sounding once every hour

Global ALE High Frequency Network Pilot Channel Frequencies

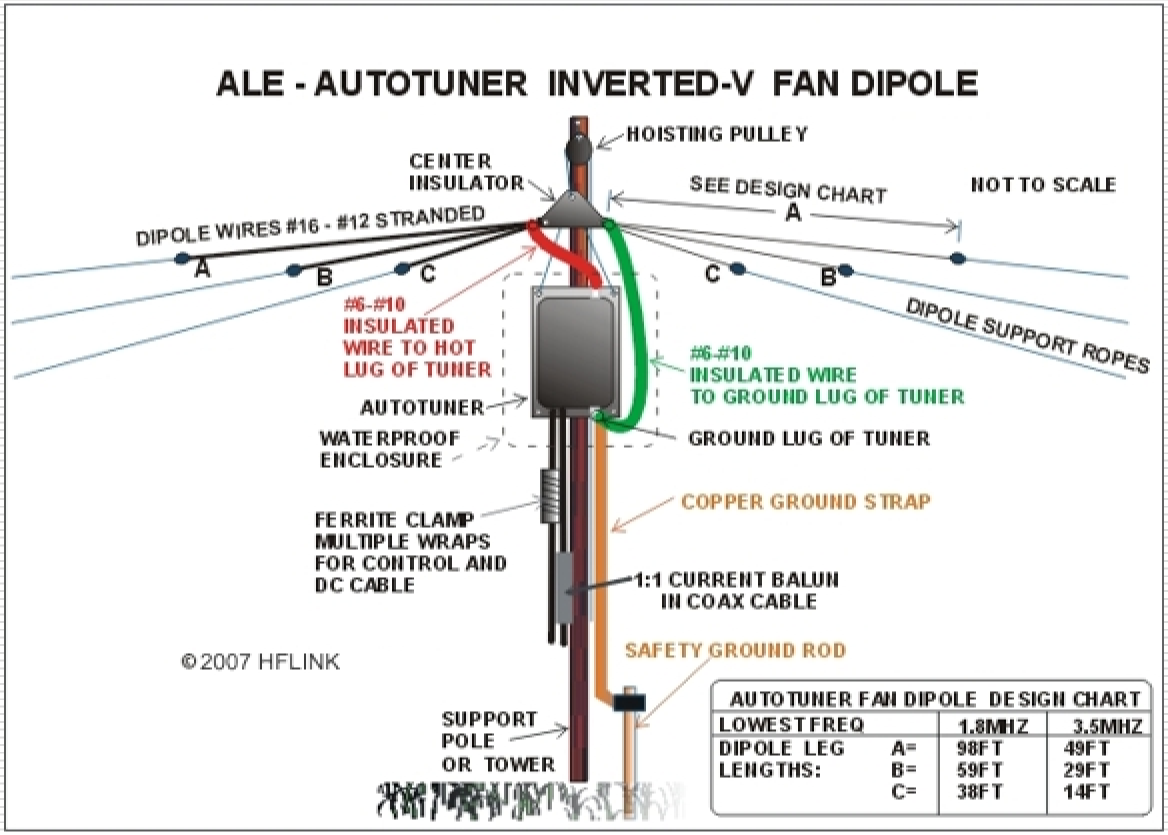
- Freq kHz / SSB INTERNATIONAL REGION - AREA
- 3596.0 USB NORTH AMERICA - SOUTH AMERICA
- 3617.0 USB EUROPE-AFRICA-RUSSIA-MIDEAST
- 3626.0 USB ASIA - AUS - NZ - PACIFIC
- 7040.5 USB EUROPE-AFRICA-RUSSIA-MIDEAST-S.AMERICA
- 7102.0 USB NORTH AMERICA - PACIFIC - ATLANTIC
- 7185.5 USB AUSTRALIA
- 10145.5 USB GLOBAL
- 14109.5 USB GLOBAL
- 18106.0 USB GLOBAL
- 18117.5 USB EUROPE-AFRICA-RUSSIA-MIDEAST
- 21096.0 USB GLOBAL
- 21116.0 USB EUROPE-AFRICA-RUSSIA-MIDEAST
- 24926.0 USB GLOBAL
- 28146.0 USB GLOBAL
- 28312.5 USB EUROPE-AFRICA-RUSSIA-MIDEAST

Transceivers Recommended for ALE

- PCALE will function with almost any amateur or commercial HF radio
- For rapid channel scanning, PCALE uses the computer-to-radio CAT interface to control the transceiver frequency and mode
  - ICOM → IC746, IC746PRO, IC7400, IC756PRO (Milspec 1030E-DSP), IC756PRO2, IC756PRO3, IC765, IC775, IC781, IC7800 (except mixer relays), PA relays handled by use of SPLIT VFO, all support up to 2 ch/sec scan rate, newer models at 9600 baud up to the 5 ch/sec and those that can do 19,200 baud at 10 ch/sec scan rate
  - KENWOOD → All Kenwood models after, but excluding the TS-440, PA relays handled by use of SPLIT VFO, all support up to 2 ch/sec scan rate, newer models at 9600 baud up to 5 ch/sec and those at 19,200 baud at 10 ch/sec scan rate
  - YAESU → FT-920, FT-990 with SPLIT VFO (FT-890 with special QS/S modification) all can do up to 2 ch/sec scan rate.
  - HARRIS → Harris RF-350 family: RF-350, RF-350K, RT-1446 URC, AN/URC-119, AN/URC-121(V) PA relays handled by BYPASS command, supports up to 2 ch/sec scan rate.

Source: http://hflink.com

Antennas for ALE

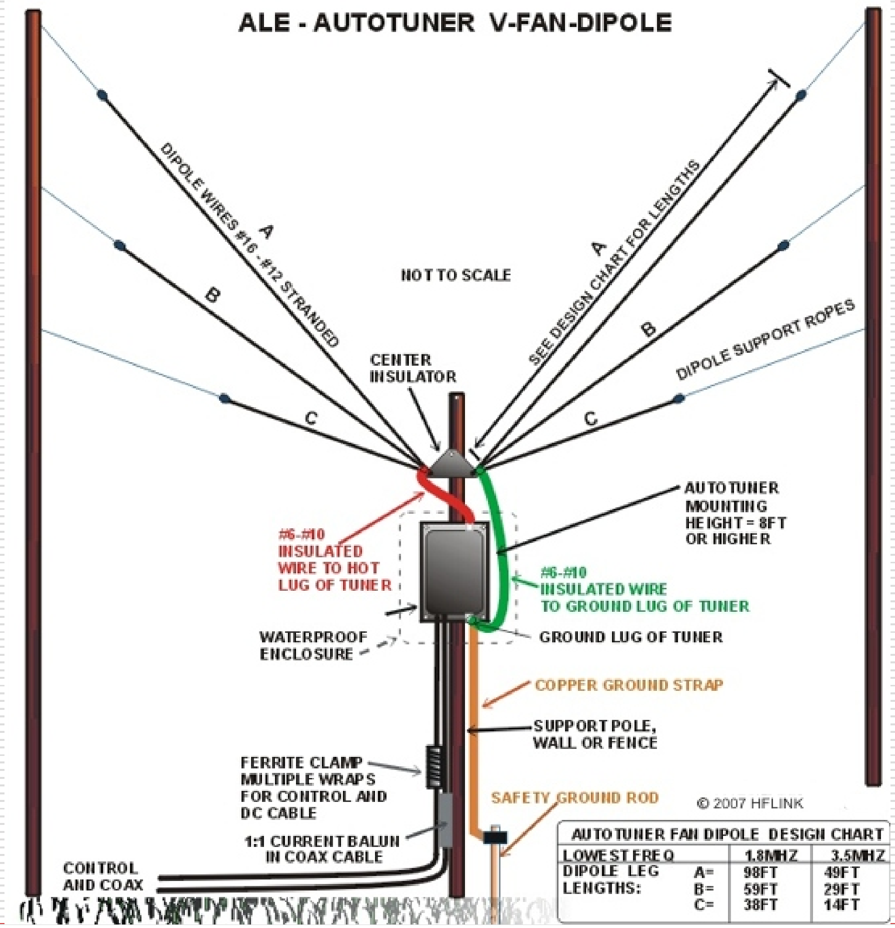

ALE - AUTOTUNER INVERTED-V FAN DIPOLE
HOISTING PULLEY
CENTER INSULATOR
SEE DESIGN CHART
A
NOT TO SCALE
DIPOLE WIRES #16 - #12 STRANDED
A
B
C
C
B
DIPOLE SUPPORT ROPES
#6-#10 INSULATED WIRE TO HOT LUG OF TUNER
#6-#10 INSULATED WIRE TO GROUND LUG OF TUNER
AUTOTUNER
WATERPROOF ENCLOSURE
GROUND LUG OF TUNER
COPPER GROUND STRAP
FERRITE CLAMP MULTIPLE WRAPS FOR CONTROL AND DC CABLE
1:1 CURRENT BALUN IN COAX CABLE
SAFETY GROUND ROD
©2007 HFLINK
SUPPORT POLE OR TOWER

AUTOTUNER FAN DIPOLE DESIGN CHART

LOWEST FREQ		1.8MHZ	3.5MHZ
DIPOLE LEG LENGTHS:	A=	98FT	49FT
	B=	59FT	29FT
	C=	38FT	14FT

Source: http://hflink.com

Antennas for ALE


ALE - AUTOTUNER V-FAN-DIPOLE

DIPOLE WIRES #16 - #12 STRANDED
A
B
C
NOT TO SCALE
SEE DESIGN CHART FOR LENGTHS
A
B
C
DIPOLE SUPPORT ROPES
CENTER INSULATOR
AUTOTUNER MOUNTING HEIGHT = 8FT OR HIGHER
#6-#10 INSULATED WIRE TO HOT LUG OF TUNER
#6-#10 INSULATED WIRE TO GROUND LUG OF TUNER
GROUND LUG OF TUNER
WATERPROOF ENCLOSURE
COPPER GROUND STRAP
SUPPORT POLE, WALL OR FENCE
FERRITE CLAMP MULTIPLE WRAPS FOR CONTROL AND DC CABLE
SAFETY GROUND ROD
1:1 CURRENT BALUN IN COAX CABLE
CONTROL AND COAX

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AUTOTUNER FAN DIPOLE DESIGN CHART

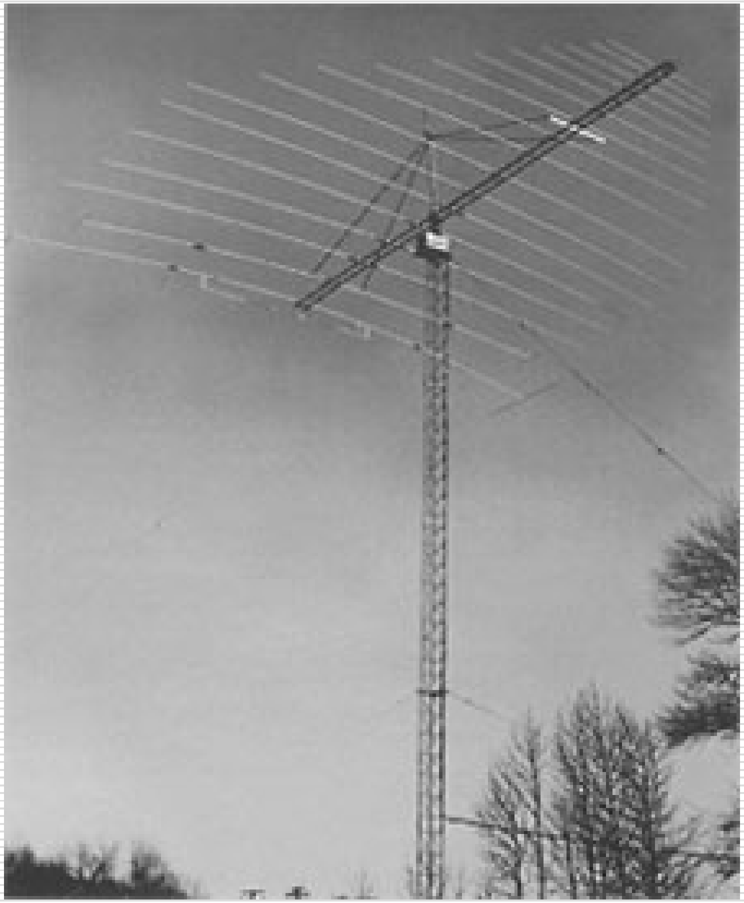
LOWEST FREQ		1.8MHZ	3.5MHZ
DIPOLE LEG LENGTHS:	A=	98FT	49FT
	B=	59FT	29FT
	C=	38FT	14FT

Source: http://hflink.com

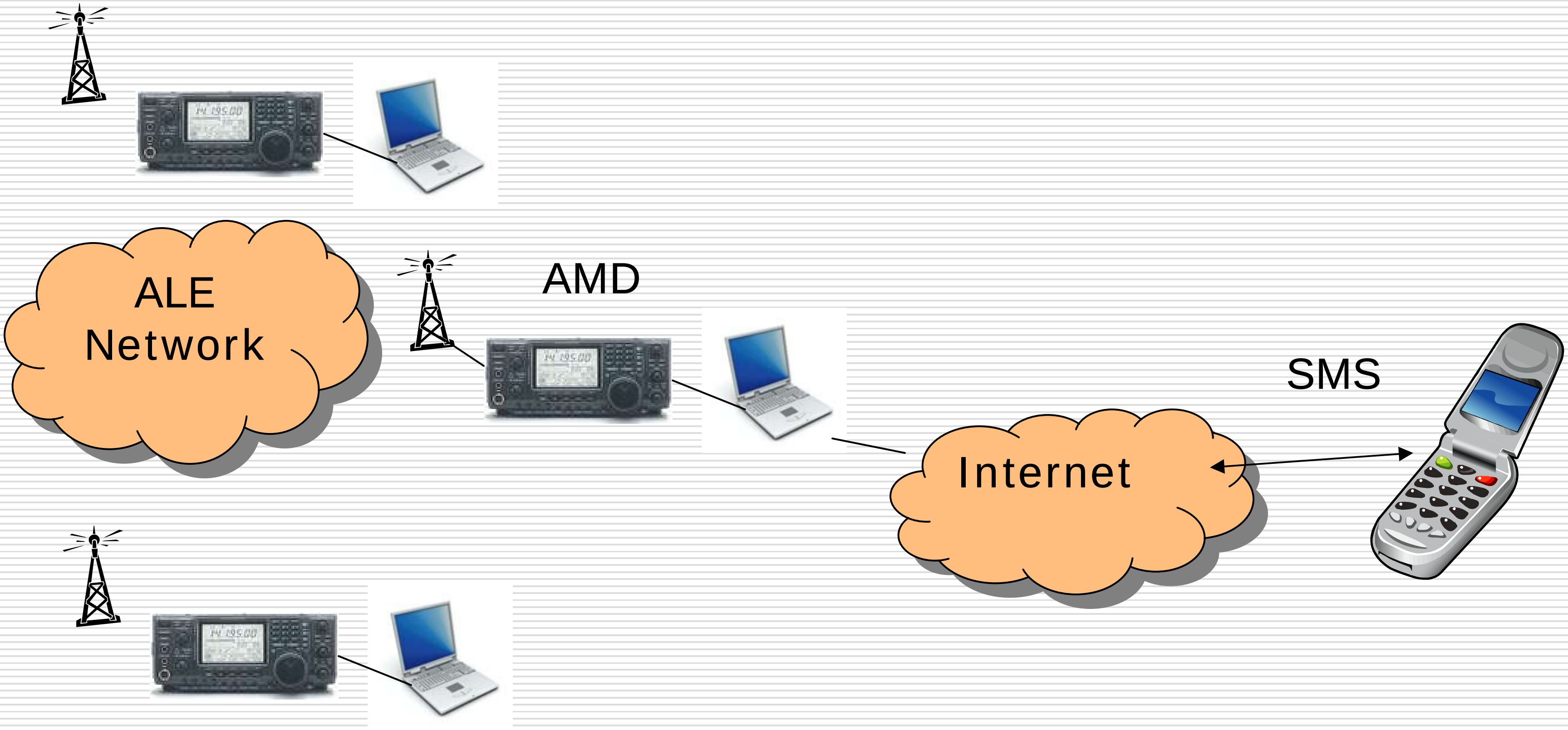
Antennas for ALE

- The LP-1017 is a commercial, lightweight, HF log periodic antenna, designed for medium to long range communications
- The LP-1017 operating range is 6.2 - 30.0 MHz and is unique as its physical size is reduced over comparable antennas
- Power rated at 2kW CW and 4 kW PEP, the LP-1017 is ideally suited for use in broadband ALE (automatic link establishment)

UNITED
STATES
ANTENNA
PRODUCTS, LLC.



ALE to/from SMS



ALE Challanges

- Interference
  - Multiple stations sounding, multiple frequencies
  - 2 channels/second
  - 30 seconds
- What frequencies?
  - Use VOACAP to find best frequencies to scan
- Antennas
  - Wide frequency range
  - Tuners → time to switch and tune
  - Both NVIS & DX antennas may be required

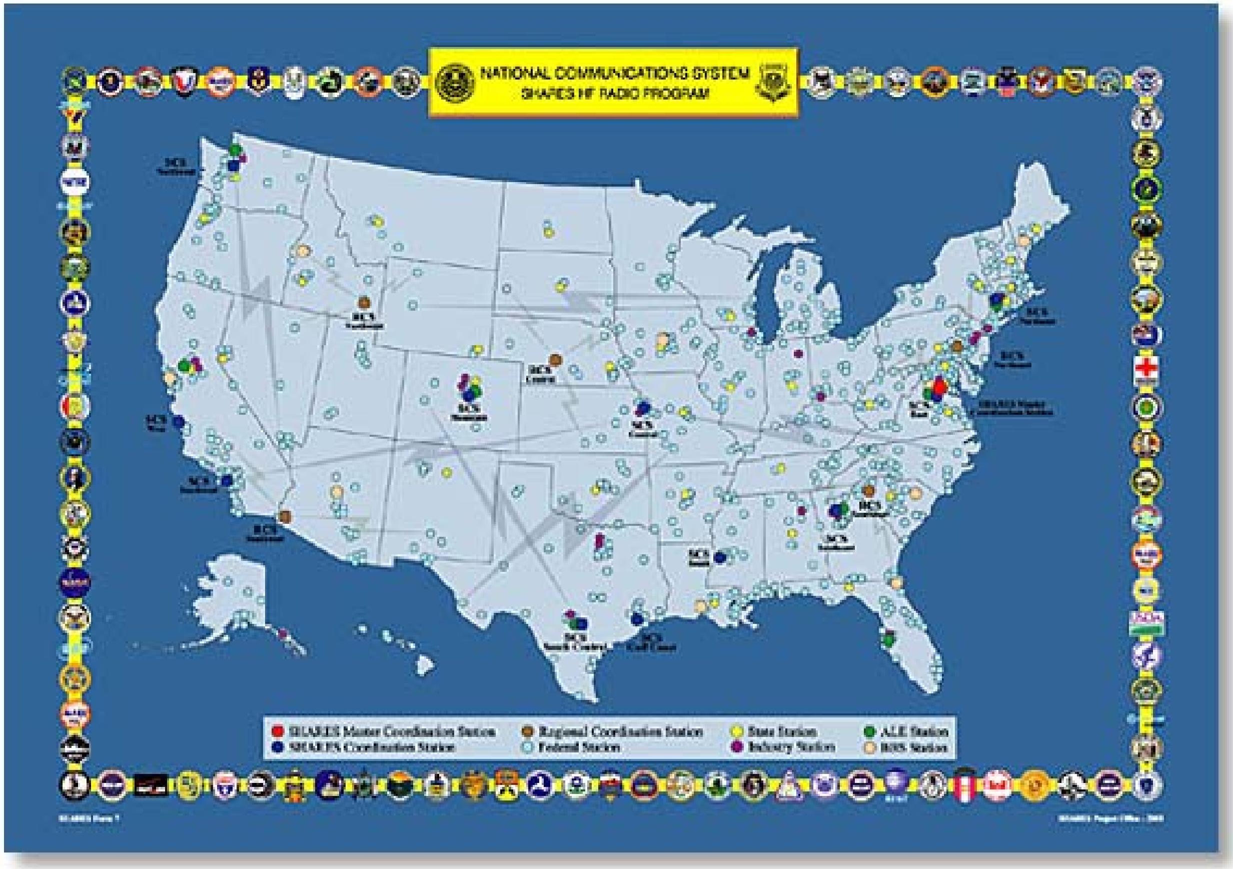
ALE Limitations

- ALE is a tool that automates HF linking and frequency selection
  - It does not replace a properly trained HF operator
  - Knowledge of the specific radio equipment being used, propagation, antennas, and so forth is still essential to use ALE effectively
- ALE will not improve propagation
  - If poor propagating frequencies are used, ALE will not make them work better
  - ALE only works as well as the frequencies you put into it; therefore, proper frequency management is essential
- ALE makes the linking process more automatic, allowing a novice HF user to use the radio effectively
  - However, ALE in some cases takes more time than it takes two highly trained HF operators to establish a link
- ALE determines only the best channel to pass traffic and tries to establish a link between radios
  - The ALE function, in itself, does not provide data capability other than a simple automatic message display (AMD) in the ALE header signal or other equipment specific features
- ALE may not determine if the channel is busy with voice or data traffic before it transmits
  - An operator has no indication if two other stations are currently linked

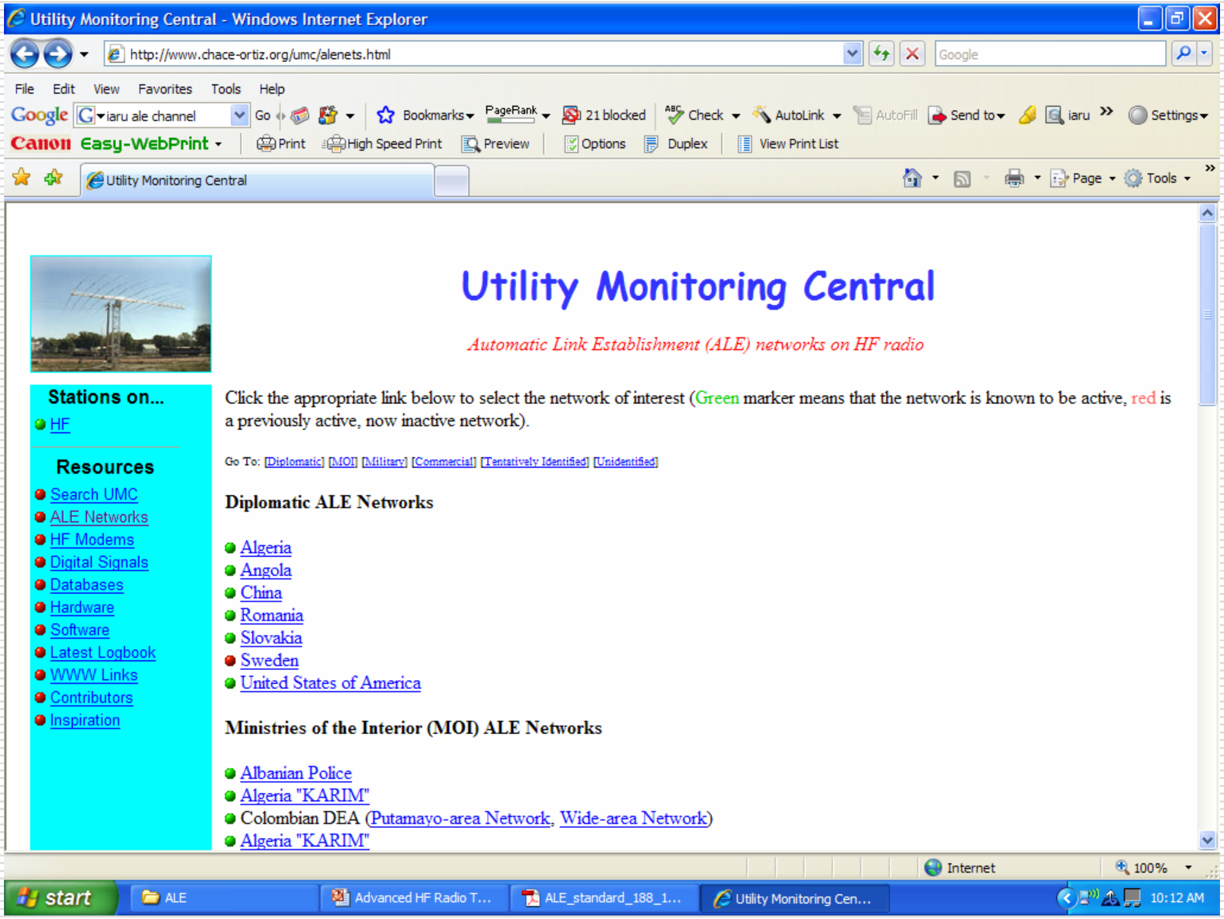
Examples of HF ALE Networks

- Air Force - HF Global Communications System Air/Ground/Air Network
- National Communication System (NCS) Shares
  - provide a single, interagency emergency message handling system by bringing together existing HF radio resources of Federal, state and industry organizations when normal communications are destroyed or unavailable for the transmission of national security and emergency preparedness information
- FEMA National Radio System (FNARS)
- U.S. Customs Service's Customs Over-the-Horizon Network (COTHEN)

SHARES


NATIONAL COMMUNICATIONS SYSTEM
SHARES HF RADIO PROGRAM
SHARES Master Coordination Station
SHARES Coordination Station
Regional Coordination Station
Federal Station
State Station
Industry Station
ALE Station

SWLing ALE


Utility Monitoring Central - Windows Internet Explorer
http://www.chace-ortiz.org/umc/alenets.html
File
Edit
View
Favorites
Tools
Help
Utility Monitoring Central
Internet
100%
start
ALE
Advanced HF Radio T...
ALE_standard_188_1...
Utility Monitoring Cen...
10:12 AM

Stations on...

- 🟢 HF

Resources

- 🔴 Search UMC
- 🔴 ALE Networks
- 🔴 HF Modems
- 🔴 Digital Signals
- 🔴 Databases
- 🔴 Hardware
- 🔴 Software
- 🔴 Latest Logbook
- 🔴 WWW Links
- 🔴 Contributors
- 🔴 Inspiration

Utility Monitoring Central

Automatic Link Establishment (ALE) networks on HF radio

Click the appropriate link below to select the network of interest (Green marker means that the network is known to be active, red is a previously active, now inactive network).

Go To: [Diplomatic] [MOI] [Military] [Commercial] [Tentatively Identified] [Unidentified]

Diplomatic ALE Networks

- 🟢 Algeria
- 🟢 Angola
- 🟢 China
- 🟢 Romania
- 🟢 Slovakia
- 🔴 Sweden
- 🟢 United States of America

Ministries of the Interior (MOI) ALE Networks

- 🟢 Albanian Police
- 🟢 Algeria "KARIM"
- 🟢 Colombian DEA (Putamayo-area Network, Wide-area Network)
- 🟢 Algeria "KARIM"

http://www.chace-ortiz.org/umc/alenets.html

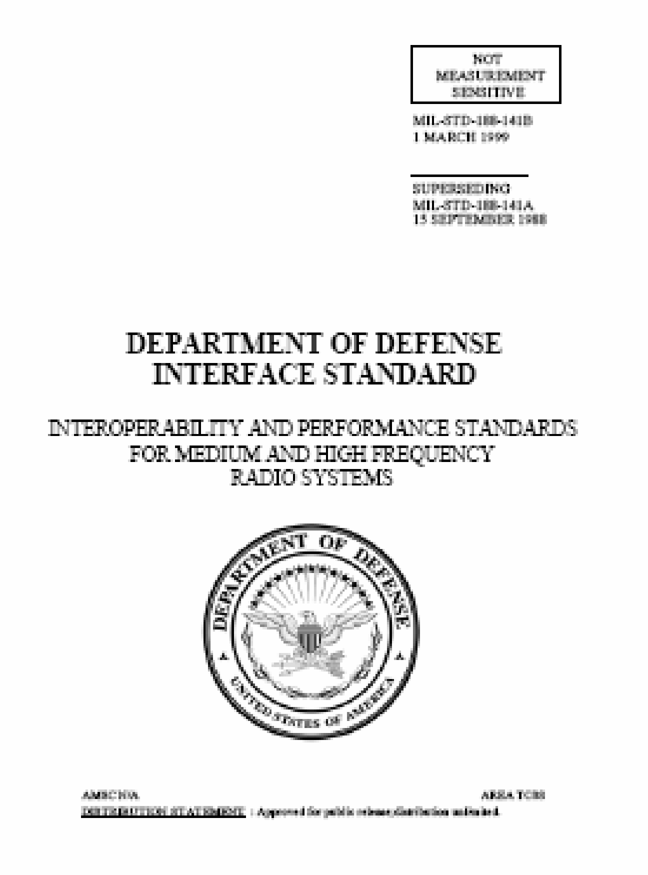
Commercial Grade Equipment

Harris RF-7210A
Autolink II ALE Controller

References

- Amateur ALE
  - http://hflink.com/
- NTIA ALE Handbook
  - http://www.its.bldrdoc.gov/pub/oa-rpt/hf-ale/handbook/
- Australian Government IPS Radio & Space Services
  - http://www.ips.gov.au/HF_Systems
- National Weather Service Space Weather Prediction Service
  - http://www.swpc.noaa.gov/
- HF Shares
  - http://www.ncs.gov/shares/
- Federal Standard 1037C
  - http://www.its.bldrdoc.gov/fs-1037/fs-1037c.htm

For more details …



NOT
MEASUREMENT
SENSITIVE

MIL-STD-188-141B
1 MARCH 1999

SUPERSEDING
MIL-STD-188-141A
15 SEPTEMBER 1988

DEPARTMENT OF DEFENSE
INTERFACE STANDARD

INTEROPERABILITY AND PERFORMANCE STANDARDS
FOR MEDIUM AND HIGH FREQUENCY
RADIO SYSTEMS

AMSC N/A AREA TCSS
DISTRIBUTION STATEMENT : Approved for public release;distribution unlimited.

Johnson, E.E., et al.,
"Advanced High-Frequency Radio Communications".
ISBN 0-89006-815-1,
Artech House, 1997